SIXTH ANNUAL REPORT SAN FRANCISCO OAKLAND BAY BRIDGE

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This copy of the Sixth Annual Report of the San Francisco-Oakland Bay Bridge, dated July 1, 1939, has been published to provide the authorities having interest therein with a complete record thereof, and is issued to

Note—

¶ This is Volume VI of a series of annual reports on construction and operation of the San Francisco-Oakland Bay Bridge and its electric railway facilities.

¶ Preceding volumes were as follows:

¶ Volume I: July 1, 1933, to June 30, 1934. Legislation, financing, construction progress.

¶ Volume II: July 1, 1934, to June 30, 1935. Construction.

¶ Volume III: July 1, 1935, to June 30, 1936. Construction.

¶ Volume IV: July 1, 1936, to June 30, 1937. Completion of construction of the Vehicular Bridge; opening of the Bridge; start of construction on the Bridge Railway; operations and maintenance of the Vehicular Bridge.

¶ Volume V: July 1, 1937, to June 30, 1938. Construction progress of the Bridge Railway; operation and maintenance of the vehicular facilities.

¶ Volume VI, July 1, 1938, to June 30, 1939, contains an account of the completion of construction of the Bridge Railway; opening of the Bridge Railway; construction of additional facilities for the Vehicular Bridge; operation and maintenance of the Vehicular Bridge and refinancing operations. There is appended thereto an account of triangulation; a description of geological foundations; a report on insurance.

GOVERNOR CULBERT L. OLSON

Chairman, California Toll Bridge Authority

SIXTH ANNUAL
REPORT
SAN FRANCISCO-OAKLAND BAY BRIDGE

. . JULY 1, 1939 . .

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THE
SAN FRANCISCO–OAKLAND
BAY BRIDGE

Designed and Constructed by the **DEPARTMENT OF PUBLIC WORKS *of the* STATE OF CALIFORNIA *for the* CALIFORNIA TOLL BRIDGE AUTHORITY**

Operated and Maintained by the **SAN FRANCISCO-OAKLAND BAY BRIDGE DISTRICT OF THE DIVISION OF HIGHWAYS, DEPARTMENT OF PUBLIC WORKS**

CALIFORNIA TOLL BRIDGE AUTHORITY: Culbert L. Olson, *Governor;* Ellis E. Patterson, *Lieutenant Governor;* Frank W. Clark, *Director, Department of Public Works;* Phil S. Gibson, *Director, Department of Finance;* Lawrence Barrett, *Chairman, California Highway Commission.*

SAN FRANCISCO-OAKLAND BAY BRIDGE DIVISION, DEPARTMENT OF PUBLIC WORKS: Frank W. Clark, *Director.*

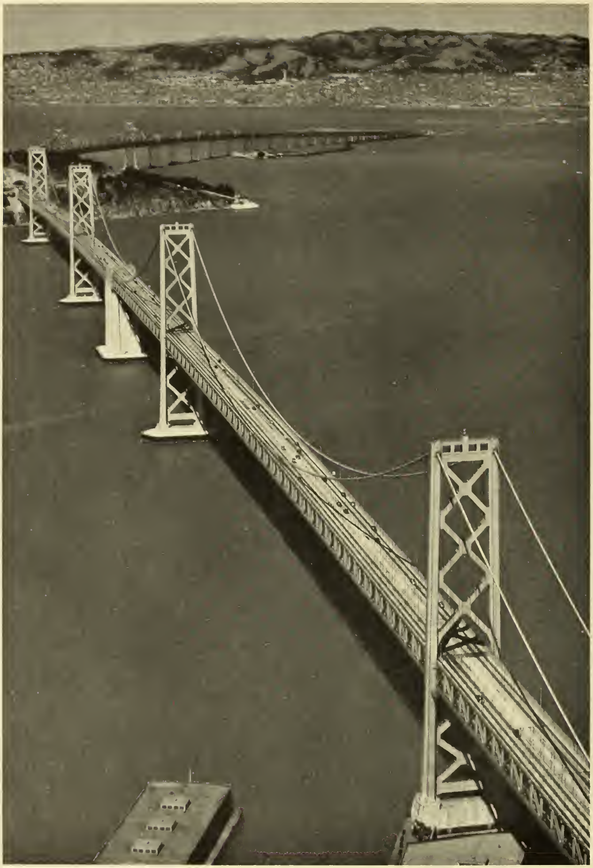
Construction: C. H. Purcell, *Chief Engineer;* Charles E. Andrew, *Bridge Engineer* (resigned March 1, 1939); Glenn B. Woodruff, *Engineer of Design, Principal Bridge Engineer* (from December 15, 1938).

Operation and Maintenance: C. H. Purcell, *State Highway Engineer;* Charles E. Andrew, *Principal Bridge Engineer* (resigned March 1, 1939); Ralph A. Tudor, *Principal Bridge Engineer* (from March, 1939).

RECONSTRUCTION FINANCE CORPORATION—BOARD OF DIRECTORS: Jesse H. Jones *Chairman;* Henry Morgenthau, *Secretary of the Treasury, ex officio;* Charles B. Henderson; Howard J. Klossner; C. B. Merriam; Emil Schram; George R. Cooksey, *Secretary;* H. A. Mulligan, *Treasurer;* Claude E. Hamilton, Jr., *General Counsel;* Morton Macartney, *Chief, Self-Liquidating Division;* Frank W. Kuehl, *Counsel;* W. L. Drager, *Chief, Engineering Section.*

BOARD OF CONSULTING ARCHITECTS: Arthur Brown, Jr.; John J. Donovan; Timothy L. Pflueger.

ATTORNEYS: Herbert W. Erskine and Edward P. Murphy.



Aerial View of the Bridge, Looking East

PREFACE

As the concluding volume of the several reports on construction of the San Francisco-Oakland Bay Bridge, this book marks the completion of a magnificent engineering work, ranking among the greatest construction achievements.

Conceived in his dreams of the future, the Bridge stands as a monument to man's ability to co-operate. It represents the joint effort of thousands of citizens and hundreds of public and private agencies. As for the men who actually built it: to the Chief Engineer, Mr. C. H. Purcell, who shouldered the responsibility of planning and building this history-making bridge, and who so efficiently directed its construction; to the able and hard-working engineers on his staff; and to the workers whose pride in their job contributed so much to the perfection of the vast undertaking, the highest praise is due.

The Bridge, now in use more than two and one-half years, also proves to be a very practical monument. It has trebled transbay vehicular traffic. The Bridge Electric Railway, in operation since last January, is carrying seventy thousand persons across San Francisco Bay every weekday, free from the dangers and delays of fog and storm. It saves passengers an average of fifteen minutes over ferry transportation.

The California Toll Bridge Authority negotiated for a lower interest rate on the Bridge bonds. As a result, the Authority accomplished a twenty per cent reduction in tolls. Average vehicular tolls are now one-half the pre-bridge average of eighty-three cents.

These Bridge bonds are so-called "Revenue Bonds." Principal and interest are payable only out of the operating revenues. They were first underwritten by the Reconstruction Finance Corporation. After negotiation of the lower interest rate above referred to (and other changes favorable to the Authority), the Reconstruction Finance Corporation sold the bonds to private buyers, last June. The bonds found a ready market at a handsome premium—a profit in which the Bridge Authority shared.

Thus, by giving the people a highway across the five-mile expanse of deep water; by giving travelers convenient, time-saving transit; by giving motorists reduced tolls; the San Francisco-Oakland Bay Bridge is already fulfilling the dreams of the men who conceived it, and the promises of the men who planned and built it.

It fully justifies the principle and the practice of public ownership.

Culbert L. Olson

CULBERT L. OLSON
Governor of California

To His Excellency, **CULBERT L. OLSON,** ***Governor of California, and Members of the California Toll Bridge Authority***

GENTLEMEN:

There is transmitted herewith the Sixth Annual Report of Charles H. Purcell, Chief Engineer of the San Francisco-Oakland Bay Bridge.

This Report concludes the account of major construction on the Bridge and its Railway Facilities.

Two outstanding events occurred during the fiscal year: first, the beginning of interurban operations across the Bridge; second, the refinancing by the California Toll Bridge Authority of Bay Bridge revenue bonds at a lower interest rate and subsequent reduction of tolls. This transaction was made concurrent with the sale by the Reconstruction Finance Corporation of the bonds to syndicates for public purchase.

The Department of Public Works takes pleasure in presenting this Report for your consideration.

Respectfully submitted

Frank W. Clark

FRANK W. CLARK
Director of Public Works

To the Honorable **FRANK W. CLARK,** *Director of Public Works*
of the State of California

SIR:

Herewith is submitted the Sixth Annual Report of the San Francisco-Oakland Bay Bridge for the fiscal year July 1, 1938, to June 30, 1939.

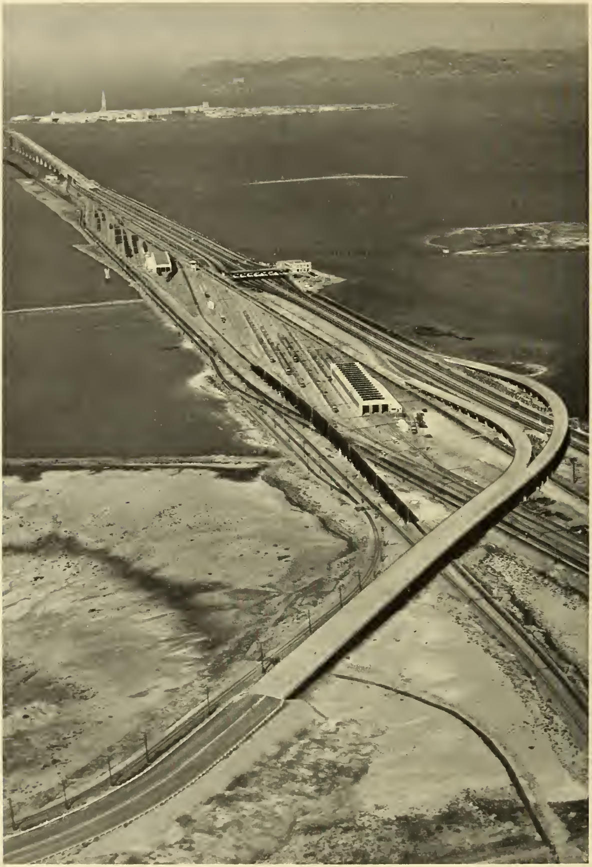
The report is separated into two parts: Part One, Construction, which tells of the completion of the Bridge Railway and includes items of general construction having to do with the maintenance and operation of the Bridge; Part Two, Operation and Maintenance, which contains a report of Bridge traffic and revenues, of refinancing, and of general administrative problems involved in Bridge operation.

In concluding this report on construction, which, except for minor items, terminates the final stage in the erection of the San Francisco-Oakland Bay Bridge, I should like to express my appreciation for the able and loyal support given me by the engineering and office staff; for the fine cooperation of the contractors, and the efficiency of the workmen—from laborer to structural iron worker—who were employed throughout the years of the building of the Bridge.

It is with pride, sir, that I report the Bridge completed.

Respectfully submitted

C. H. PURCELL
Chief Engineer



Aerial View
East Bay Yard,
Railway Facilities,
and Port of Oakland
Highway Approach

SIXTH ANNUAL PROGRESS REPORT

. . . PART I . . .

CONSTRUCTION

Bridge Railway Facilities

Summary

Bridge Railway facilities were described in the Fifth Annual Report. By the beginning of the fiscal year the major contracts had been let and work was under way in the various sections of the project simultaneously.

These contracts included: construction of the San Francisco Terminal; San Francisco viaduct; signal and interlocking system; Bridge and loop track work; East Bay Yard track work; Southern Pacific connections, including those at 7th and Bay Streets, Oakland, and at Lincoln Junction, Alameda; Southern Pacific-Santa Fe Interchange Yard; Seventh Street and Alameda connections; power distribution system; and alterations and additions to the rolling stock of the Key System and Interurban Electric.

New Contracts Awarded

Railroad contracts awarded during the fiscal year were the telephone system, inspection buildings in the East Bay Yard; Terminal additions, and alterations to Sacramento Northern equipment.

The Key System transferred its operations on the mole in the East Bay from its mainline tracks to the tracks of the Bridge Railway in that section August 21, 1938. (See also page 52.) The first test train to operate on the Bridge made the crossing from the East Bay Yard to Pier W-1 September 23, 1938, and regular Bridge Railway operations started Sunday, January 15, 1939. (See page 62.)

San Francisco Terminal

⟦Contract No. R-2⟧

General

This contract, described in the Fifth Annual Report, was divided into Contracts R-2A, R-2B, R-2C and R-2D, providing for general construction, structural steel, mechanical work and electrical work, respectively. These will be discussed under their separate classifications below.

Concessions

Terms of the agreements between the California Toll Bridge Authority and the Key System and Interurban Electric Railroads, provided that San Francisco Terminal concessions be managed by the railroad companies, subject to approval by the Authority. Rentals derived from the concessions are paid the Authority.

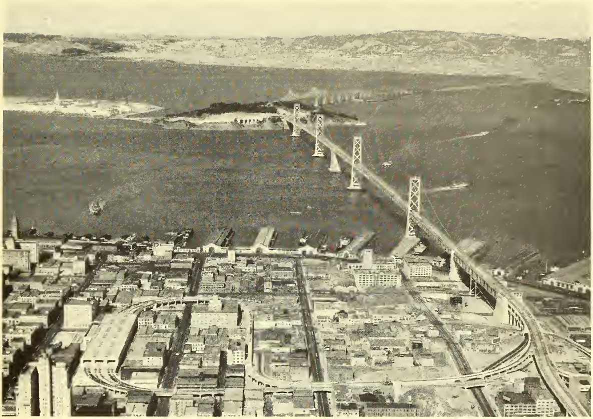
Concessions Itemized

Accordingly, the Railroads dispatched invitations for interested parties to bid on these concessions. Contracts were awarded to the following:

Concession C-1 —Mainline ticket office—Southern Pacific Company
Concession C-2 —Travel agency and telegraph office—Greyhound Bus Lines

James A. Gray, Inc., was awarded the following concessions:

Concession C-3 —Soda fountain and lunch counter
Concession C-4 —News stand (center unit, mezzanine)



San Francisco Terminal and Viaduct for the Bridge Railway Facilities

Concession C-8 —Flower stand
Concession C-9 —Refreshment lounge
Concession C-10—News stand and drugs
Concession C-11—Fruit stand
Concession C-12—Candy stand

The National Service Company was awarded the following concessions:

Concession C-5 —News stand (center unit, mezzanine)
Concession C-6 —News stand (west unit, mezzanine)
Concession C-7 —News stand and parcels (lobby)
Concession C-13—Restaurant and news stand (waiting room)
Concession C-14—Bootblack stand

Concession Terms

Terms of the leases required that concessionaires install all fixtures according to standards fixed by the Department of Public Works.

All concessionaires, except for lessees of Concessions C-1 and C-2, who pay a definite monthly rental, pay to the Authority a percentage of gross revenues with a minimum monthly rental.

In addition to the concessions itemized above, there are also telephone and vending machine concessions.

At the end of the fiscal year concession areas remaining to be let included the store spaces on the west side of First Street and east side of Fremont Street and garage space in the Terminal.

General Construction (Contract No. R-2A)

Major concreting operations for the Terminal structure were well under way at the beginning of the fiscal year. Concreting had been completed in the center unit, and formwork construction was far advanced for the west and east units.

Work on the interior of the center unit was progressing simultaneously; while the first floor terrazzo was being ground, the placement of the mezzanine floor terrazzo was under way. At the same time, installation of metal furring and lathing continued and plastering operations had just been started at the beginning of the fiscal year. The granite facade for the headhouse was eighty per cent completed.

Sandblasting and painting of the roof steel, skylights, and viaduct steel were in progress.

All operations were carried through to completion in a coordinated manner, and on November 23, 1938, the contract was recommended for acceptance.

CONCRETE

Concrete Proportions

Specifications required that all concrete should contain not less than five sacks of cement per cubic yard of concrete and that additional cement could be used at the discretion of the Engineer. Experience and tests showed that the greatest workability and economical strength were obtained from mixes of five sacks per cubic yard in footings, basement slabs, sidewalks and curbs and track ballast. Five and one-half sacks per cubic yard were used in all concrete above the basement and in concrete paving. Six sacks per cubic yard were used in the concrete piles.

FORMS

Specifications required five-eighths inch plywood forms and the architects' drawings showed the form panels arranged somewhat similar to the granite blocks of the headhouse facade. In the interior of the building, at the track level, a symmetrical system of paneling was worked out. Patent form clasps were used to hold two by four studs, placed at a maximum of fourteen-inch centers, and four by six wales. These provided rigid forms with minimum deflection.

Metal Forms Used

In cases of columns where the concrete was to be exposed, metal forms were used. Rough wooden forms were employed where the columns were to be furred out for tile or plaster.

HOLLOW TILE

Hollow tile used in the partitions had each horizontal joint reinforced with expanded metal lath. Each door opening lintel and jamb was reinforced with reinforcing rods.

Normally the partitions required three-inch hollow tile, but in heights of over fifteen feet, or where pipes or conduits required concealing, four-inch tile was used.

GRANITE

The granite facing for the headhouse was four inches thick. It was placed on the front and sides of the headhouse and on the streetcar ramp wall in front. Galvanized metal hooks and dowels anchored the granite blocks to galvanized anchors which had been cast in the reinforced concrete walls.

As each stone was placed, the space between the stone and concrete was solid-filled with grout.

ROOFING, DAMPPROOFING AND WATERPROOFING

Composition roofing was placed over the headhouse, train shed, service garage and marquees of the structure. The contractor spot-mopped the first sheet to the concrete surface. The balance of the flat roof assembly, consisting of four layers of forty-pound roofing, was then lapped and mopped according to specifications. All metal flashings, flanges, and vents were installed in asphalt, between the roofing sheets, and properly flashed.

The backs of the parapet walls were dampproofed by application of a heavy fibre coating mopped on solidly. Exterior concrete walls below the finish grade of the streets and the Plaza were treated with two coats of Inertol.

Exterior Concrete Waterproofed

Waterproofing treatment was required under the tracks at the west end of the train shed, under the street railway track and on the streetcar ramp in front of the headhouse. The treatment called for the installation of a membrane consisting of four layers of asphalt-treated felt, one middle layer of asphalt-treated cotton fabric, with six moppings of asphalt. Asphalt plank, one-and-a-quarter-inches thick, formed the protection beneath the tracks, but a fine mix asphaltic concrete surfaced with an emulsion was used for the protection of the track platforms and the platforms of the streetcar ramp.

TRACK BALLAST AND VIBRATION INSULATION

Tracks Insulated

Before placing concrete track ballast in the six track troughs in the Terminal, a vibration pad, consisting of two one-inch layers of premolded cane fibre and asphalt, was installed.

Reinforcing steel was then placed. Timber ties, placed under Contract R-9, (refer to page 44) were next installed. Pouring of the concrete, which followed, was executed under the Terminal contract.

The three streetcar track troughs were constructed in similar fashion to the train track troughs within the Terminal, except that steel ties were used. These ties were furnished by the City of San Francisco (Municipal Railway Company) and were placed by MacDonald & Kahn under separate contract with the City.

ALUMINUM

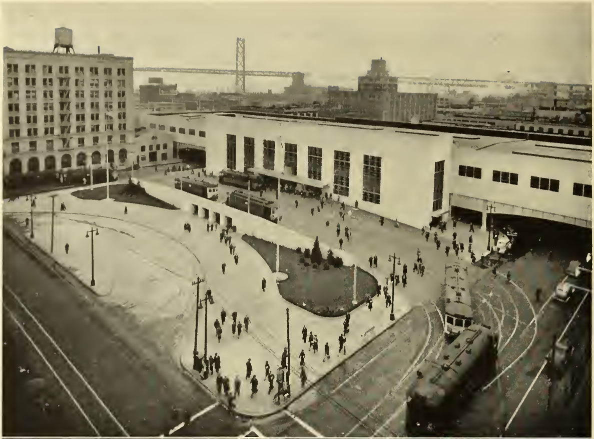
Aluminum work in the Terminal included the installation for the fascia and soffits on the three marquees of the headhouse; windows and window sills of the headhouse; soffits of door openings from the headhouse to the waiting room, from the exterior to the lobby and from the exterior to the headhouse; exterior signs; and switch tower.

Except for the sheets, all aluminum was extruded.

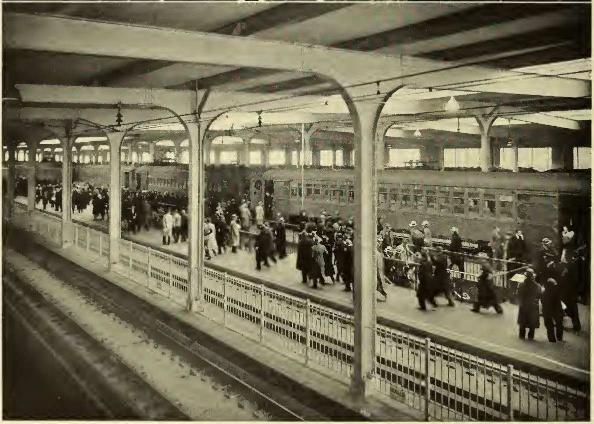
METAL LATHING AND FURRING

Metal lathing and furring were placed on ceilings, partitions, walls and columns not tiled, and at those locations where pipes or ducts were to be concealed.

Metal one-inch runner channels fastened to number eight gage galvanized wire hangers had been previously placed in the concrete. When spanning large ducts, heavier runner channels were used to eliminate vibration. Three-fourths-inch furring channels were wired to the runner channels.



San Francisco Terminal



Track Floor, San Francisco Terminal

ACOUSTICAL TREATMENT

Acoustical treatment was provided by placing a rock wool blanket above the furring channels before the installation of metal lathing. This treatment was used only in the mezzanine concourse, ramp ceilings, and in the lobby ceiling where it was desirable to reduce the noise from train and streetcar traffic.

INTERIOR PLASTERING

The interior plastering on metal lath required three coats: a scratch coat, brown coat and finish coat. The final coat was given a smooth, hard, white finish except on the ceilings of the east and west concourses and other isolated specified places which received a sand float finish.

TERRAZZO FLOORS

The ground floor lobby beneath the streetcar ramp; the waiting room and mezzanine concourse of the center unit have terrazzo floors.

The rough concrete floors of these spaces had been constructed three inches below finish grade. Over the concrete a thin layer of sand was placed, not exceeding a quarter-inch in thickness. Screeding gave it a uniform surface.

Brass Dividing Strips

Asphalt-saturated felt paper was placed upon the sand and covered with an under-bed of concrete which had an imbedded reinforcing of number eighteen gage one-inch hexagonal welded wire. Brass dividing strips were next installed. This under-bed was then permitted to set two days before the terrazzo was placed.

Two parts of five-eighths-inch and three-eighths-inch marble chips of selected colors were mixed with one part of cement and sufficient water to attain workability. The mixture was placed on the concrete and compacted into place with rollers. Marble chips were then spread on the surface in the amount of eighty-five pounds per hundred square feet. Alundum aggregate was also applied to provide a non-slip surface.

Grinding

All free mortar was brought to the surface by rolling compaction and removed. The first grinding started after a week's minimum curing. Power-driven abrasive wheels ground the surface until the brass dividing strips showed and the marble chips presented a uniform appearance.

The surface was again treated with a thin, neat cement grout and coloring. Final grinding completed the operations.

The finished work presented a light-gray floor patterned by squares formed by the brass dividing strips.

OTHER FLOORS

East and west unit concourses, the headhouse floor and all ramps have cement floor surfaces. Fine alundum, added to the material used on the ramps, provided a non-slip texture. Anti-slip treads were placed on all stairs and landings having a cement finish.

TERRA COTTA TILE

The walls and columns of the lobby, center unit waiting room, mezzanine concourse, wainscot walls of the headhouse, and walls of the ramps and stairways connecting these areas were faced with terra cotta unit tile of a soft buff color having

Finishing Waiting Room Benches, October 26, 1938

a light blue background. An eight-inch black tile base set off the buff color of the wall tile. This base was continued around all waiting room benches. Wall tile was pointed with white cement, and the base, with black.

PAINTING

Steel for the Terminal was cleaned by light sandblasting, which proved efficient, economical and satisfactory regardless of the fact that this process required protection for city traffic, adjacent buildings and construction work in progress.

Painting closely followed sandblasting and all steel was painted the same day it was cleaned. This was made possible without damage to fresh paint by careful coordination of shifts and operations.

Spray painting was adopted for all but a few locations where protection of adjacent property and construction became too expensive.

Structural Steel Painted

All structural steel was given two coats of lead and oil paint, and one of aluminum.

Finishing of exterior concrete surfaces was accomplished by application of two coats of paint. Light buff in color, the paint covers the entire exterior concrete surfaces of the structure, blending well with the granite facade of the headhouse.

General painting items included ornamental and miscellaneous metalwork, painting of hollow tile, concrete and plaster, woodwork, metalwork, lettering, numbering and other similar items.

Wainscoting

The walls of the track floor and those ramps that were not tiled received a dark wainscot, and in many cases the height of the wainscot was raised to preserve the appearance and cleanliness of the painted walls. Galvanized metal requiring painting received a previous treatment of copper acetate.

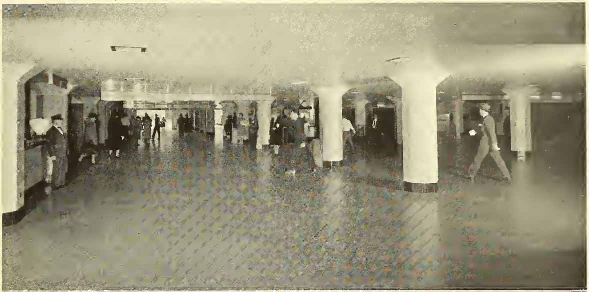
Interior painting was all applied by brush.

MISCELLANEOUS ITEMS

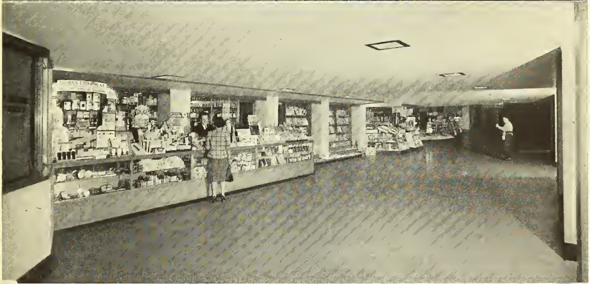
Among other items included under this contract were:

Finish hardware, which has an oil-rubbed light statuary bronze finish except for the lavatories, where hardware is of chromium.

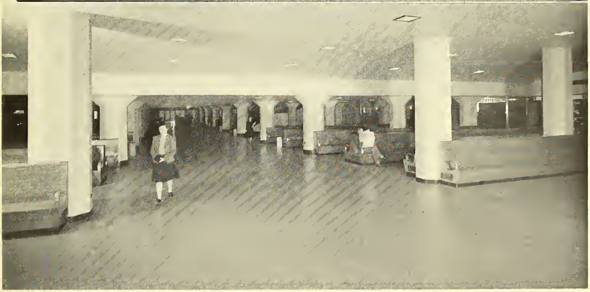
Flagpoles, two in number, are steel ground-set, heavy-pattern seventy-seven feet in length, painted white and each topped by an eight-inch gold-leaf copper ball.



Mezzanine Concourse, San Francisco Terminal



Concessions, Street Floor Lobby



Waiting Room

Garage, Basement of West Unit, San Francisco Terminal

Bronze expansion plates were placed at the ends of the connecting viaducts on the Howard Street and Beale Street piers.

Fire extinguishers included soda and acid, foam, carbon tetrachloride, pressure, and tetrachloride and carbon dioxide types. Sand buckets, hose reels and an inclusive system of fire alarms supplement the fire protection system of the structure.

Street work in the vicinity of the structure was required after the demolition of the old buildings. The work also included the paving of parking areas beneath the west viaduct between Natoma and Howard Streets and the east viaduct.

Old Tracks Removed

Drainage installation was necessary due to the change in grade and general reconstruction of streets adjacent to the project. The work included the construction of new and reset catch basins, new connections to sewers and the placing of additional vitrified clay pipe. Removal of Market Street Railway tracks beneath the structure on First Street was also required. The Public Utilities Department of the City of San Francisco and the Market Street Railway Company cooperated fully with the State in these operations.

Fencing was erected to enclose parking areas and to provide pedestrian and vehicular gates at required locations.

Elevators. Two hydraulic freight elevators, salvaged from the buildings during demolition, were renovated and installed in the Terminal.

Summary

The contract was awarded July 16, 1937, to MacDonald and Kahn Company of San Francisco on a low bid of $1,658,510. Work started July 17, 1937. Recommendation for acceptance was made November 23, 1938, and the contract was accepted December 2, 1938.

QUANTITIES

Removal of concrete	9,245.40 cubic yards
Excavation	35,621.10 cubic yards
Fill	27,911.30 cubic yards
Existing piles pulled	16
Cutting off existing piles	1,395
Timber piles	218,094.00 linear feet
Concrete piles	10,771.00 linear feet
Concrete foundations	8,860.76 cubic yards
Concrete basement slabs	5,960.50 cubic yards
Concrete curbs	212.56 cubic yards
Concrete above foundations	23,741.40 cubic yards
Extra Portland cement	3,512.00 barrels
Reinforcing steel	6,641,176.00 pounds
Painting steel street crossings	1,926.62 tons
Painting terminal roof steel	500.64 tons
Painting catenary bridges	294.83 tons
Waterproofing exterior concrete surfaces	10,580.00 square yards
Flagpoles	2
Bronze expansion plates	1,664.00 pounds
Redressing granite curbs	100.00 linear feet
Resetting granite curbs	100.00 linear feet
Granite curb, straight	302.00 linear feet
Granite curb, curved	54.00 linear feet
Brick catch basins	17
Asphaltic concrete	1,461.52 tons
Liquid asphalt, type MC-3	4.50 tons
Stone screenings	39.50 tons
Street castings	4,778.00 pounds
Resetting street castings	13
Vitrified pipe, 10-inch	524.00 linear feet
Painting interior concrete surfaces	18,013.30 square yards
Painting third coat in headhouse	2,484.00 square yards
Painting wainscot and miscellaneous	1,000.00 square yards
Painting exterior concrete	10,580.00 square yards

COSTS

Costs

Amount of contract items	$1,843,337.29 *
Total extra work orders	16,509.21
Total paid to contractor	$1,859,846.50

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* This sum also includes stair treads, firebrick, hollow tile, granite, roofing, dampproofing, waterproofing membrane and protection, vibration insulation, sheet metal, steel flooring, miscellaneous iron, ornamental iron, aluminum, steel windows, steel hollow metal, rough carpentry, finish carpentry, metal lathing and furring, interior plastering, acoustical treatment, terrazzo, Kalman floor, marble, glazed and ceramic tile, terra cotta unit tile, asphalt tile and linoleum, glass and glazing, general painting, finish hardware, fire extinguishers, general cleaning, fencing, elevators, and demolition and removal of buildings not under contract R-1A.

Personnel

Felix Kahn is president of MacDonald and Kahn Company, and B. F. Modglin, vice president. Dallas Young was construction superintendent for the contractors.

N. W. Reese was resident engineer for the State on this contract and the following related contracts for the Terminal.

Structural Steel (Contract No. R-2B)

Status of Work, June 30, 1938

At the close of the last fiscal year structural steel for the Terminal and street crossings had been erected and this phase of the contract completed except for minor welding and grinding. There remained approximately eighteen per cent of the contract to be completed, consisting mainly of catenary bridge construction.

Catenary Bridges

The erection of catenary bridges for the viaduct loop started July 12, 1938.

Dardalet Bolts Replace Rivets

Trucks hauled the structural steel to a point adjacent to the site of the catenary bridge to be erected. A sixty-foot boom crane, having a twenty-ton lifting capacity, raised the steel to the viaduct deck where a truck-mounted crane lifted the member to its premanent position. Dardalet bolts replaced the usual rivets for all catenary bridge erection.

A total of forty-five catenary bridges was erected under this contract. Work was completed August 15, 1938.

Summary

The contract was awarded to the Columbia Steel Company July 16, 1937, on a low bid of $442,360. Work started July 20, 1937, and was completed, except for minor items, by August 18, 1938. The contract was accepted October 7, 1938.

QUANTITIES

Structural steel crossings	3,809,915 pounds
Steel roof framing in Terminal	1,000,503 pounds
Catenary bridges	566,839 pounds

COSTS

Amount of contract items	$419,229.32
Total extra work orders	6,900.51
Total paid to contractor	$426,129.83

Personnel

Ambrose Diehl is president of the Columbia Steel Company; J. R. Fox is contract manager.

Mechanical Work (Contract No. R-2C)

Status of Work, June 30, 1938

At the end of the last fiscal year there remained thirty-five per cent of this contract to be completed. Boilers, pumps and ventilating fans were in place in the center unit. Work was under way on plumbing installation in the east unit and the placement of leader lines under the west viaduct and track level. Duct work had been started in the basement of the west unit.

General

This contract provided for the furnishing and installation of equipment for a ventilating, heating, plumbing and draining system. Items involved are included in the following:

PLUMBING FIXTURES AND SERVICE PIPING

Extra heavy cast-iron pipe was used for soil and waste piping. Soil and waste lines lead from their respective outlets to connect to the city sewers or storm drains. Basement sewage and drainage are pumped into the above gravity systems.

Connections to City Sewers

Plumbing fixtures in public lavatories are of vitreous china with concealed valves and piping.

ROOF AND TRACK DRAINAGE SYSTEM

The roof and tracks required a separate drainage system to carry rain water to city sewers so as not to place too heavy a load on the sanitary system.

This drainage system is comprised of extra heavy galvanized steel leader pipe and galvanized cast-iron fittings above the ground level; extra heavy cast-iron soil pipe for the basement runs and vitrified clay sewer pipe connections to the city drains.

HOSE RACK AND WATER PIPING SYSTEMS

Water supply for the Terminal originates from the city main through a three-inch metered service entering the basement of each building unit. From these services, branches lead to three supply systems: cold water supply to all fixtures; hot water supply to certain fixtures; and fire protection supply to hose racks.

In the hot and cold water systems, plugged outlets are provided for concession areas, and the cold water also connects to the east unit basement elevator pumps.

Hot and Cold Water System

GAS PIPING SYSTEM

Service pipes from the city mains supply gas to the meter rooms for the Terminal. In the center unit a four-inch metered line runs from the meter room to the boiler room and other extensions run from the meter rooms to plugged outlets in the concession areas for service hook-ups by lessees.

BOILER SYSTEM

A dual boiler system was installed in the Terminal under this contract. Its purpose is to supply low-pressure steam for radiator heaters in all units; to heat water for the circulating system in the center unit and to heat the fresh air supply at the center unit fan rooms.

Furnishing and installation of pumping equipment were included in this item. This equipment was placed in the basement of each unit to eject basement drainage to the city storm sewers and to lift the center unit basement sewage to the city sewer system.

All equipment and auxiliaries are automatically controlled.

RADIATION AND STEAM HEATING SYSTEM

Steam Lines Insulated

This item comprised steam and return piping systems outside the boiler room; radiators; coil heaters for heating ventilating air in the center unit; and plugged steam and return line branches in the concession areas. All steam lines, valves and fittings are insulated.

STATION VENTILATION

The air supply and exhaust ventilation systems supply fresh air and exhaust ventilation in the center unit above the basement, and in the boiler room in the basement, and exhaust ventilation only at the east and west unit concourses and the center unit mezzanine concession areas.

The systems include all of the necessary ducts, motors, fans, grilles, and automatic controls to maintain the desired temperatures and air flow conditions.

GARAGE VENTILATION

A ventilating system was installed in the garage space of the west and center units. Exhaust vents and ducts extend throughout the garage areas, and sidewalk openings supply air to the basements.

Summary

This contract was awarded to the Scott Company of San Francisco July 16, 1937, on a low bid of $109,257. Work started September 28, 1937, and was completed for recommendation of acceptance December 30, 1938. The contract was accepted January 1, 1939.

Costs

COSTS

Amount of contract items	$109,779.04 *
Total extra work orders	5,981.73
Total paid to contractor	$115,760.77

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* This sum includes plumbing fixtures and service piping; roof and track drainage system; hose rack and water piping system; gas piping system; boilers, oil tank, pumps and piping; radiation and steam piping; station ventilation; garage ventilation.

Personnel

William P. Scott, president of the Scott Company, was in direct charge of the project for the contractors.

Electrical Work (Contract No. R-2D)

Status of Work, June 30, 1938

By the close of the last fiscal year conduits over First Street had been placed, and condulet placement had started at the track level. Installation of electrical facilities was under way in the west unit.

General

As described in the Fifth Annual Report, this contract included the installation of electrical wiring and fixtures required for the operation of the San Francisco Terminal.

The major items included under this contract are discussed in the following paragraphs.

GENERAL LIGHTING

This item covered the conduit systems for lighting, telephones and burglar alarm, wiring, panel boards and the switchboard required for the building and parking area lights.

Materials incorporated in the electrical facilities for the Terminal consist of sherardized iron conduit, rubber-covered wire with thirty per cent A-O compound insulation, and thermal circuit breakers on all panels and switchboards. A three-phase, 208-volt, sixty cycle, four-wire system of lighting distribution was employed.

EMERGENCY LIGHTING

Thirty Minute Emergency Lighting

An emergency lighting system, consisting of a sixty-cell storage battery and control panel, was installed in the switchboard room. Certain lights on the ramps, stairs and track platforms are wired single-phase from the main switchboard. In case of a power failure, automatic throw-over contactors in the control panel throw these emergency lights over to the battery circuit, which will provide lighting facilities for thirty minutes.

When service is restored the battery is thrown off the line by the automatic equipment. The control panel also contains charging equipment to keep the battery fully charged at all times. The battery also supplies current for switching, clocks and fire alarms.

PUBLIC ADDRESS SYSTEM

Loudspeakers, located in the waiting room, mezzanine concourse, and track platforms connect with a microphone and amplifier in the superintendent's office. Any or all speakers may be operated at the same time.

POWER WIRING

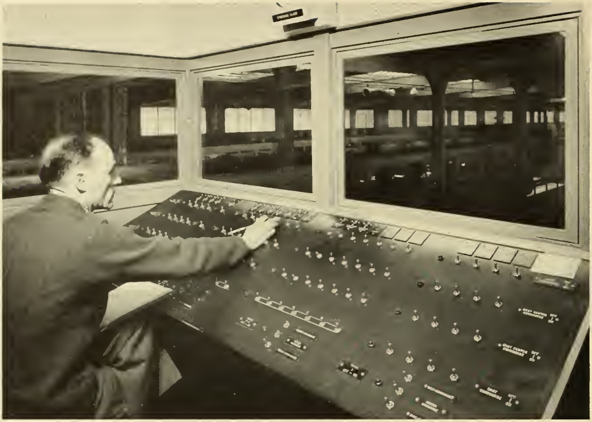
While all motors and starters were supplied under the contract for mechanical work (Contract R-2C, refer to page 27), wiring and installation of this equipment were executed under the contract for electrical work.

Remote Control for Ventilating System

Remote control is used for all fans ventilating the building. A control board is located in the boiler room with start and stop buttons for fans and vacuum pumps. Red indicator lights show the units in operation. The ventilation of the entire structure may be controlled from the boiler room.

Installation of feeders to the fan rooms, part of the main building feeders located in the structure, and feeders to the concessions were included in this contract. All wire and cable was insulated with thirty per cent rubber class A-O compound, and was pulled in rigid iron sherardized conduits.

Power for the Terminal is supplied from the Sterling Street substation (Refer to Volume V, Power Distribution). Installation of transformers, oil switch with



Control Board for Train Indicator Signs, San Francisco Terminal

automatic throw-over controls, 12,000-volt three-phase cable and conduits necessary for the transmission of this power in the Terminal was covered in this contract under an additional work order.

LIGHTING FIXTURES

Track Platforms Lighted

Due to low headroom, recessed lighting units were adopted for the waiting room and concourses of the Terminal. Track platforms are lighted by high bay units, and garages and unfinished areas have dome reflectors. Fremont, First and Natoma Street crossings are illuminated by special street lighting units.

FIRE ALARM SYSTEM

The fire alarm system employed for the Terminal is an auto-call type "DDP" which permits the sounding of preliminary signals in the boiler room and superintendent's office. It also registers the call on a tape in the Terminal police station. Should the fire be serious, a second call goes in to the city fire department.

CLOCKS

A master clock, located in the switchboard room, and secondary clocks, for the waiting room and concourses, track platforms and signal tower, comprise the clock system of the Terminal.

The secondary clocks operate on alternating current but are corrected every minute by a direct current impulse sent out by the master clock. The latter is regulated by a mercurial compensating pendulum, and is spring-driven and electrically wound. In case of power failure, a small alternator driven by battery keeps the clocks in service.

Under an additional work order clocks were installed at each of the eight train control stations on the track platforms. As these were synchronized with the clock in the signal tower and in the public rooms, exact departure schedules may be maintained without depending on trainmen's individual watches.

A standard clock was also installed in the superintendent's office and telechron clocks, operating on alternating current only, were placed in other offices.

SIGNS

Directional signs were placed in all concourses. The signs were sandblasted into plate glass, backed with a black background and mounted in bronze cases. The wording, lighted indirectly through the glass, glows greenish-white against the black background.

Train Destination Signs

Train destination signs in the concourses were supplied and installed under the contract for general construction (Contract R-2A, refer to page 18).

The electrical system for the destination signs comprises a control board mounted on the track platform and four relay panels which are mounted near the concourses. When a small switch on the control board is thrown, the corresponding relay closes, lighting the respective sign which specifies train and track number. Red indicator lights on the board show which signs are lighted in the concourse below.

Summary

This contract was awarded to Radelfinger Brothers of San Francisco July 16, 1937, on a low bid of $73,250. Work started August 5, 1937, and was completed for recommendation of acceptance February 28, 1939. The contract was accepted March 14, 1939.

COSTS

Costs

Amount of contract items	$82,417.39 *
Total extra work orders	8,704.06
Total paid to contractor	$91,121.45

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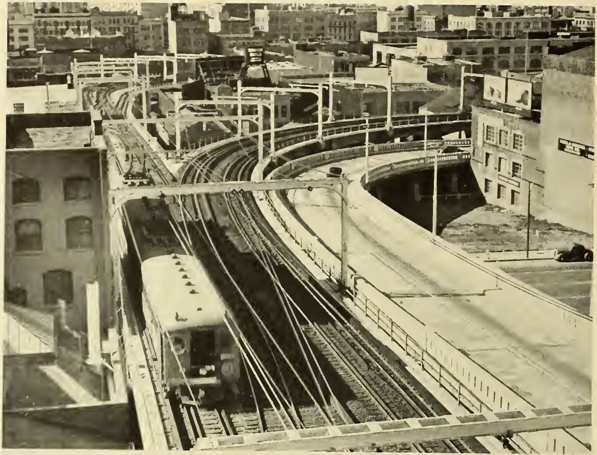
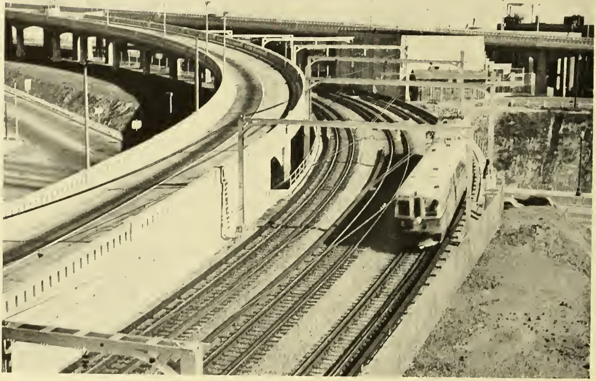
* This sum includes general lighting, lighting fixtures and standards, fire alarm system, clocks, signs, public address system, power wiring, emergency lighting.

Personnel

S. M. Radelfinger, owner of the contracting firm, and Fred Dresser were in charge of the project for the contractors.



Viaduct, Looking North Toward the San Francisco Terminal



San Francisco Viaduct Connection to the Bridge

San Francisco Viaduct

[[Contract No. R-3]]

Status of Work, June 30, 1938

At the start of the fiscal year approximately eighty-eight per cent of the structural concrete for the viaduct had been poured. Drainage installation and street work had closely followed construction operations.

General

This contract was described in the Fifth Annual Report. All structural work was completed by July 28, 1938. There remained to be finished installation of the drainage system, pipe railing, expansion tees, street work and general cleanup. These were completed by November 10, 1938.

Major items involved in the construction of the San Francisco viaduct are discussed below.

Concrete Above Foundations

Concrete for this project was mixed at a plant located at Carolina and Mariposa Streets, and brought to the site of the pour in three and one-half and six-cubic-yard mixing trucks. The concrete was unloaded from the trucks into a hopper at the bottom of a skip and hoisted to platforms from which it was buggied to the pour.

Form Construction

The contractor laid out a yard adjacent to the right of way on Beale Street, with layout tables, power saws and work benches, in addition to a field office and storehouse. The forms for the entire project were built in panels in this yard, so that the only form-work operations at the structure consisted of the erection of falsework and assembly of the forms. Duplication of spans made for speed and economy of erection.

Typical spans were framed as follows: ten-inch by ten-inch posts rested on three-foot square sills and were supported by twelve-inch by eighteen-inch stringers placed under each girder. The joists measured two inches by eight inches and were topped by four-inch by four-inch ribbons for wedging the studs. Form panels were made up of five-ply, five-eighths-inch plywood with two-inch by four-inch studs and joists, and two-inch by six-inch wales with five-eighths-inch tie rods at thirty-foot centers.

Concrete Deck on Steel Spans

Deck Forms Suspended

Deck forms for these spans were made up in panels in the yard and hung from the steel work with three-eighths-inch bolts attached to the hangers straddling the floor beams and stringers. The hangers were one-inch furring channels.

Waterproofing Deck

Two coats of Inertol were placed on the deck and curb surfaces. The first coat was placed immediately after each pour to act as a curing membrane. The second coat was placed after the first was completely dry. A pressure sprayer was used for this work.

Summary

The contract was awarded to Eaton and Smith of San Francisco August 19, 1937, on a low bid of $605,350. Work started October 11, 1937. The contract was completed for recommendation of acceptance November 15, 1938, and accepted November 18, 1938.

QUANTITIES

Excavation, unclassified	24,615.4 cubic yards
Excavation, structure	15,187.0 cubic yards
Cutting off existing piles	48
Timber piles	44,265.0 linear feet
Concrete piles	9,677.0 linear feet
Concrete in foundations	5,003.0 cubic yards
Concrete above foundations	12,442.0 cubic yards
Concrete deck on steel spans	1,495.0 cubic yards
Extra Portland cement	1,492.0 barrels
Reinforcing steel	2,933,252.0 pounds
Miscellaneous steel work	103,639.0 pounds
Bronze expansion plates	5,913.0 pounds
Pipe railing	100,336.0 pounds

Costs

COSTS

Amount of contract items	$595,547.84 [*]
Total extra work orders	19,200.31 [†]
Total paid to contractor	$614,748.15

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[*] This sum includes demolition and removal of buildings, waterproofing deck, drainage, and street work.

[†] This sum includes fencing of right of way areas.

Personnel

H. C. Snead was manager and engineer; George T. Warren, superintendent; and Joseph E. Armstrong, resident engineer, for the contractors.

N. W. Reese was resident engineer for the State.

Signals and Interlocking

⟦Contract No. R-5⟧

The general design of the signal and interlocking equipment was described in the Fifth Annual Report.

Status of Work, June 30, 1938

At the beginning of the fiscal year the signal and interlocking work was practically half completed. Seventeen carloads of equipment and fourteen carloads of cable had been delivered. Operations in the East Bay Yard were concentrated largely on the connection of equipment, while on the Bridge cable placement was under way. Cases and impedance bonds, and line and power cable had been installed from the east end of the Yard to Yerba Buena Anchorage.

Progress

Work had progressed to such an extent in the East Bay Yard that on July 11, 1938, circuit tests were started for the Oakland interlocking system. These tests were completed the following August 19.

Key System trains were cut-over to the new tracks Sunday morning, August 21, (see also pages 52 and 58) operating under the signal system in the area east of the Key trestle.

California Railroad Commission Tests

The California Railroad Commission initiated its tests at ten o'clock that morning, completing them by one p.m. One round trip at each of the four control speeds was made with the leading train operated steadily at the desired control speed and a second train following as closely as the automatic control system would permit.

Work on the San Francisco interlocking system started August 8, 1938, and was sufficiently completed by November 1 to permit circuit tests in the San Francisco relay room. Test trains were put in operation in this area December 17, and tests were concluded December 30, 1938.

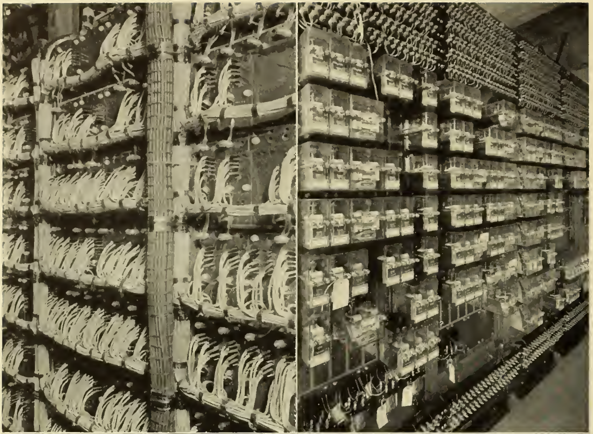
Interlocking Plant Completed

The signal and interlocking plant in the East Bay Yard was put into complete service January 2, 1939, with Key System towermen on duty. On the following day the San Francisco interlocking plant was placed in service, operating under Interurban Electric towermen.

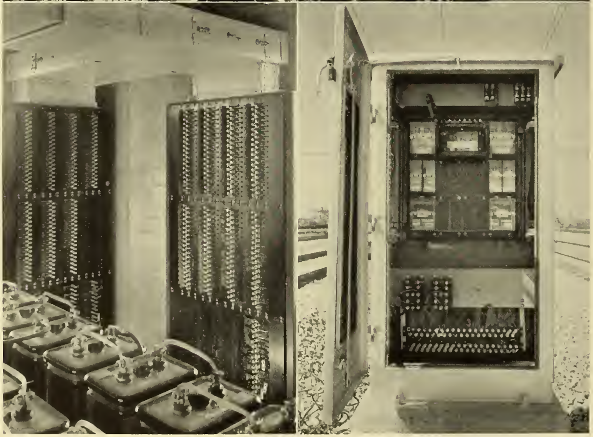
Coincidental with the final transfer of track and power connections from the temporary facilities in the East Bay Yard to the Bridge, in the early morning of January 15, 1939, signal circuits were connected in time to permit the operation of the first revenue train across the Bridge. (Refer to page 65.)

The California Railroad Commission completed tests of the East Bay Yard interlocking plant on the same day and completed code checking of Yard tracks between two a.m. and five a.m. January 16. At the conclusion of these tests verbal approval of the entire Bridge Railway system was given by the Commission's engineer.

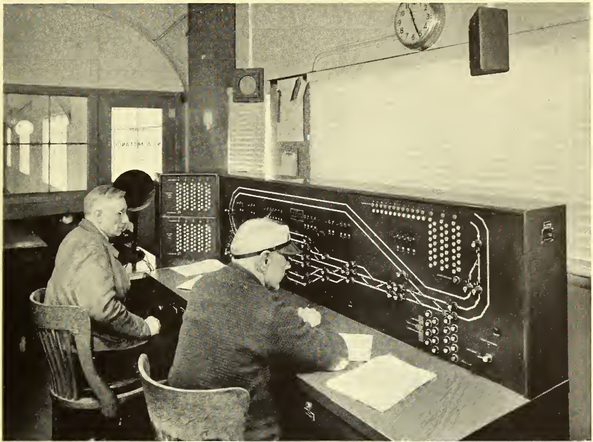
All work on the signal and interlocking contract was completed January 27, 1939, including instructions to the towermen, as provided in the agreement.



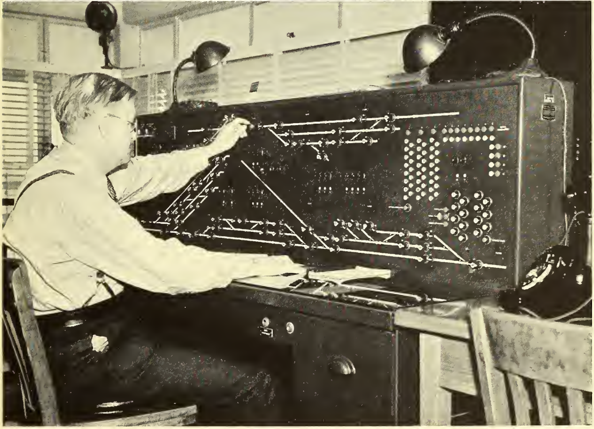
Left to Right: Rear View of the Relay Racks at the Oakland Tower; Relay Racks in the Oakland Tower



Left to Right: Terminal Racks and Batteries, Oakland Tower; Relay Housing in the East Bay Yard



Control Board for the Interlocking Plant, San Francisco Terminal



Control Board in the Oakland Tower

General

Experience in the five and one-half months of Bridge Railway operation has developed the fact that not only is this system well suited to the operations, but that no other system of interlocking would permit the arrival and departure of 1064 trains per week-day without confusing delays.

Satisfactory functioning of the entire railway system is evident in the record which shows that for the three months prior to June 30, 1939, all Bridge Railway trains had an "on time" performance of ninety-nine and one-half per cent.

Train-Describer System Modified

Two modifications were made in the train-describer system as the result of operating experience. On the few occasions when traffic was delayed, there were more than ten trains in one direction between the East Bay Yard interlocking plant and the San Francisco Terminal.

The control board describer system was large enough to indentify only ten trains and it became necessary under these conditions for the towermen to account for extra descriptions on paper, later transferring them to the board.

Five Train-Description Lights Added

Such a system tended to lead to errors. It was remedied by the purchase of additional relays and the installation of five additional description lights on the control board in the Yard and Terminal towers. This improvement made it possible to record the identities of fifteen trains in each direction between the two towers.

It was considered sufficient, in the original design, to identify trains between interlocking plants only. There were, however, some cases where operators at the San Francisco tower lost the identity of the incoming trains after they entered the interlocking territory at Rincon Hill and before they entered the Terminal.

Repeat Indicators Installed

Repeat indicators were therefore installed. These show the identity on the control board of all trains to the point where they enter the east end of the Terminal, from which point they are routed to their proper tracks.

Summary

The contract was awarded to the General Railway Signal Company of Rochester, New York, December 11, 1936, on a low bid of $1,368,402. Work started February 14, 1938, and was completed January 27, 1939. The contract was accepted February 9, 1939.

COSTS

Amount of contract items	$1,384,522.00 *
Total extra work orders	12,498.60
Total paid to contractor	$1,397,020.60

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* This sum includes cost of railway signals and interlocking; "all route" control, San Francisco interlocking; and "all route" control, Oakland interlocking.

Personnel

Paul Renshaw is president of the contracting company; A. C. Holden was resident manager; and E. W. Stone, resident engineer in direct charge of the work for the contractors.

C. R. Davis was resident engineer for the State.

Telephone System

⟦Contract No. R-6⟧

The agreements between the California Toll Bridge Authority and the railroads provided that the Bridge Railway should include "all of the communication equipment used or useful in the operation of the Bridge Railway . . ." Installation of the telephone system was made in conformity with this agreement.

Plans for the work were delayed during the progress of negotiations between the State, the railroads and the Pacific Telephone and Telegraph Company whereby the installation of this system would be made by the latter. Satisfactory arrangements could not be reached and it was therefore decided that the work should be executed by the Department of Public Works under contract.

Twenty-five New Wire Pairs to Administration Building

The communication system for the vehicular facilities of the Bridge, installed under Contract No. 11, had reached capacity. It was decided, therefore, that coincident with the installation of the Bridge Railway telephone system, twenty-five additional wire pairs should be run from San Francisco to the Administration Building at the Toll Plaza which would be available for the Bridge highway when necessity arose.

Description

The installation under Contract R-6 consists of a fifty-pair cable extending from the San Francisco Terminal to a terminal pole located at the east side of the Southern Pacific mainline tracks north of the Key Route Subway.

One pair extends from the Mole substation east of the Bridge to the substation on Yerba Buena Island; another from the Mole substation to the Sterling substation in San Francisco. These pairs permit remote control of Sterling and Island substations from the Mole substation.

Additional Facilities Installed by Railroads

From the terminal pole in Oakland the Southern Pacific connected to the Bridge telephone cable, following the company's mainline tracks. The Key System installed connecting lines to offices at Twenty-Second and Grove Streets, Oakland, and the Sacramento-Northern constructed a line to its Oakland terminal at 40th and Shafter Streets. These extensions, however, were not included in the work executed under Contract R-6 and were made at the expense of the respective railroad companies.

Telephone instruments are provided at the following locations:

San Francisco Terminal	17 instruments
Sterling substation	2 instruments
Center anchorage	2 instruments
Island substation and tie station	4 instruments
Cantilever crossovers and tie station	2 instruments
Mole substation	5 instruments
East Bay Yard	12 instruments
Southern Pacific inspection building	5 instruments
Key System inspection building	6 instruments
Sacramento Northern inspection building	2 instruments
Yard tower	2 instruments

The lines for the Interurban Electric Company are connected directly into the Southern Pacific exchange. For the Key System, specifications called for a PBX installation. The Key System provided the additional funds to change this to an automatic installation.

Standard Telephone Construction Used

Standard telephone construction was followed throughout the installation. The cables are paper-covered, lead-sheathed, and encased in a steel armor and jute protection. The cables are buried on the approaches; on the Bridge, they are located on the skid girder at the south of the railway tracks, adjacent to the signal cables.

Summary

The contract was awarded to Abbett Electric Company of San Francisco October 21, 1938, on a low bid of $16,404. Work started November 7, 1938, and was completed March 8, 1939. The contract was accepted March 14, 1939.

QUANTITIES

8	Type A local battery magneto substation sets
1	Type B local battery magneto substation set
9	Type C local battery magneto substation sets
5	Type D local battery magneto substation sets
15	Type E central battery substation sets
4	Type F central battery substation sets
11	No. 10 cable terminal boxes
7	No. 26 cable terminal boxes
1	No. 51 cable terminal box
1	PBX switchboard

Costs

COSTS

Amount of contract items	$16,587.00 *
Total extra work orders	2,146.00
Total paid to contractor	$18,733.00

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* This sum includes installation of cable and placing of cable accessories, branch wiring and lot miscellaneous work.

Personnel

George W. Abbett was in charge of the work for the contractor.

C. R. Davis was resident engineer for the State.

Inspection Buildings

⟦Contract No. R-8⟧

Inspection buildings for the maintenance and light repair of the rolling stock operated on the Bridge Railway and space for the operating personnel were required items of the interurban facilities. Logical location for such structures was in the East Bay Yard, where train crews start and complete their runs.

Erection of the superstructure of these buildings comprised this contract. Foundation construction, originally included under Contract R-4, substructure for the East Bay Yard (refer to Volumes IV and V), was transferred by extra work order to Contract R-21A, which included the track work for the East Bay Yard (refer to Volume V). This transaction was made necessary because work could not be started until Key System operations were transferred from the company's old tracks to those constructed for the Bridge Railway facilities.

Description of the Work

Buildings Described

The buildings erected and their respective areas are:

Interurban Electric inspection building	24,300 square feet
Key System inspection building	27,700 square feet
Sacramento Northern inspection building	560 square feet
Interurban Electric oil house	288 square feet
Key System oil house	400 square feet

The Interurban Electric and Key System inspection buildings are of structural steel frame, of saw-tooth construction. They are covered with corrugated asbestos. Each of these buildings has three inspection pits, facilitating inspection and car maintenance. The Sacramento Northern inspection building and the two oil houses are also of steel frame with asbestos covering.

Structural Steel

All truss and column connections for the Interurban Electric and Key System structures are, in general, riveted connections. Connections in the Sacramento Northern, Interurban Electric and Key System oil houses are bolted with machine bolts, as are the purlins and sash frames in the two main inspection buildings. The stringers in the Key System pits are bolted with Dardelet bolts.

Corrugated Asbestos

Transite Used for Building Walls

The corrugated asbestos siding consists of forty-two-inch wide sheets having ten corrugations per sheet. Sheets are fastened to the steel frames by galvanized bolts, one-quarter-inch in diameter. Lead washers are used. Copper flashing is of the best grade, sixteen-ounce weight, and the lead flashing is of four-pound chemical soft lead of the best quality.

Painting

All steel received a shop coat of red lead primer and field coats of red lead and aluminum. Before applying the primer coat the metal work was thoroughly cleaned of dirt, loose scale and rust. Painted surfaces were also cleaned before application of succeeding coats.

Key System Inspection Building

Interurban Electric Inspection Building

The under side of the roof in the Key System inspection building, above the pits, received one coat of aluminum. All other interior woodwork and fibreboard received one coat of primer, one coat of enamel and a five-foot wainscoting of darker shade topped with a gold stripe.

Plaster Walls Painted

Plaster walls received a plaster primer coat, and two coats of mill white. Exterior woodwork and shop doors were given a primer coat and second and third coats.

Summary

The contract was awarded to Fred J. Early, Jr., of San Francisco August 13, 1938, on a low bid of $132,352.50. Work started October 6, 1938, and was completed March 23, 1939. The contract was accepted April 7, 1939.

QUANTITIES

Concrete	16.42 cubic yards
Untreated timber	24.06 M.F.B.M.
Creosoted timber	3.96 M.F.B.M.
Structural steel	657,496.00 pounds

COSTS

Amount of contract items	$132,208.03 *
Total extra work orders	1,141.02
Total paid to contractor	$133,349.05

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* This amount includes corrugated roofing, siding, steel windows, rough carpentry, finish carpentry, roofing, glass and glazing, mastipave flooring, painting, finish hardware, plumbing, electrical work, sheet metal, metal partitions, lathing and plastering and general cleaning.

Personnel

Benjamin E. Nelson, superintendent, was succeeded by William Yarnell, in charge of the work for the contractors.

Harry Carter was resident engineer for the State.

Laying Ties, San Francisco Viaduct

Track Work, Bridge and San Francisco Loop

⟦Contract No. R-9⟧

Status of Work, June 30, 1938

This contract was described in the Fifth Annual Report. At the beginning of the fiscal year track work on the Bridge was within ten per cent of completion, but work on the San Francisco loop had just started. The first course of ballast had been placed for the loop tracks west of the San Francisco Anchorage. Placing of ties in the Terminal was under way.

Track Work, San Francisco Loop

LOOP TIES

Redwood and Creosoted Fir Ties Used

Redwood and creosoted fir ties were used for the loop tracks. All switch ties were of the latter.

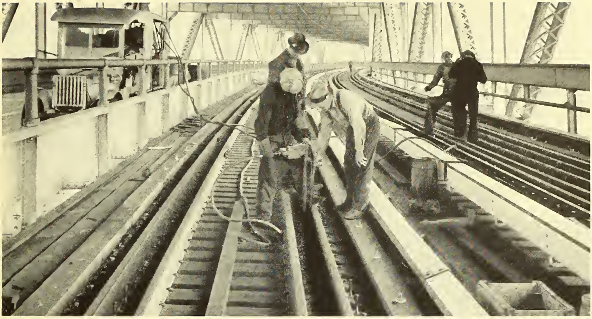
The redwood ties for the curved tracks were fitted with gage plates and numbered for track and sequence before they were hauled to the site. Maintenance of the sequence was necessary because of the predetermined location of contact rail insulators and protection board brackets which required ties from two to four feet longer than standard.

Before creosoting the fir ties, each was dapped for gage plates and insulated joints where required, and numbered as to switch and position in the switch.

TERMINAL BUILDING TIES

The major problem involved in tie placement in the Terminal arose from the necessity to retain the tie in its proper place while the concrete ballast was poured.

The ties are half ties, each supporting but one rail. They are of redwood, six inches by eight inches by two feet six inches, beveled on four sides. Each tie is secured by two five-eighths-inch galvanized bolts projected through the tie into inserts set in the concrete.



Drilling for Bolts for the Bridge Rails

An elaborate and effective method for holding the ties in place during concreting operations was devised. Timber beams were placed crosswise, ten feet apart, on two pairs of timber stringers and secured to these supports by rods running through the beam and stringer into the tie and inserted in the concrete roadbed. Ties lying between the beams were secured by shorter horizontal timbers fastened by rods to the floor base. Additional security was provided by placing running rails across the beams. Adjustments for grade were made at the beams by inserting wedges between the beam and stringers or under the beam resting on the platform level.

When the concrete had set sufficiently the supports were removed and the rods replaced with the permanent galvanized bolts.

Provision for contact rail supports was made when ties were set.

LOOP RUNNING RAILS

Rails for the curved tracks, switches and crossovers were numbered at the fabricating plant for their respective positions. For certain critical points rails were fabricated one foot longer than the calculated length required, and cut in the field to fit.

LOOP GUARD RAILS

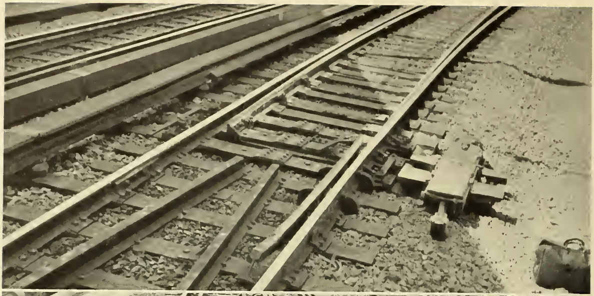
Ninety Pound Relay Guard Rails

Guard rails were made of ninety-pound relay rail. Those intended for the curved sections of the track were bent and the ends bent and beveled at the Moore Drydock Company in Oakland. A five-ton crane, mounted on a flat car, was employed in the distribution of these rails.

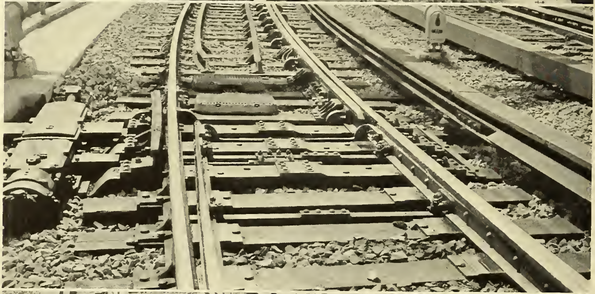
LOOP FLANGEWAY GUARD RAIL

The inside curve rails of the loop tracks are protected by a one-hundred-and-ten-pound flangeway guard rail. (Refer to Volume V.)

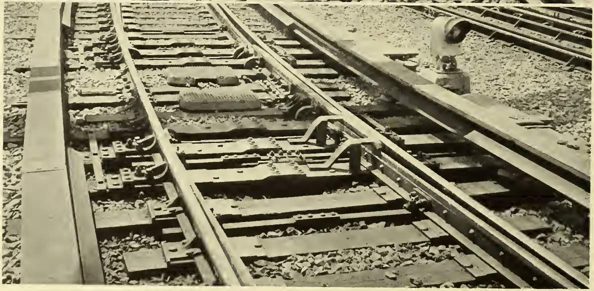
These rails were pre-bent to fit the curve of the track. They are held to gage by a pair of wedge fillers placed between the rails and clamps.



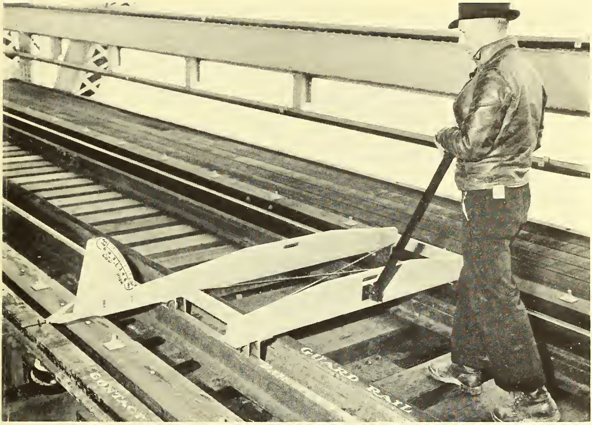
Automatic Sorting Switch, Entrance to the San Francisco Interlocking



Switch Point on a Curved Track



Guarded Switch Point on a Curved Track



Automatic Gage for Contact Rail, July 7, 1938

Where the rails are crowded, in the crossovers, through-bolts and washer-type fillers were substituted.

LOOP CONTACT RAILS

Small tolerances allowed in the position of the contact rail in the loop demanded exactitude in the curvature of this rail. The numerous differences in the degrees of curvature and spirals of the tracks resulted in the decision to curve the rails to within three degrees of that required and to make up the final alignment with a rail bender after the rail was in place.

The ease with which the rail was brought into final line justified this method.

Track Work, Yerba Buena Island

Rock Ballast for Tunnel Tracks

Rock ballast was placed in the Yerba Buena Island tunnel crossing as in the San Francisco loop.

An additional item, however, was the installation of rubber silencer pads between the rails and the tie plates.

Progress

Track work had been completed on the Bridge from Pier E-23 to the San Francisco Anchorage by the middle of August and first rails placed in the San Francisco loop. All major construction on the contract had been completed by the middle of November. There remained only final adjustments, general cleaning up and minor construction items to be done.

Summary

The contract was awarded to the Pacific Bridge Company of San Francisco September 22, 1937, on a low bid of $469,236.50. Work started October 6, 1937, and was completed January 16, 1939. Contract was accepted February 9, 1939.

QUANTITIES

Structural steel work	295,178	pounds
Framing and placing bridge ties	2,704.13	M.F.B.M.
Framing and placing spacing blocks	139.23	M.F.B.M.
Framing and placing timber guard rails	343.95	M.F.B.M.
Framing and placing walkways	340.24	M.F.B.M.
Ballast—Yerba Buena Island	2,815.80	tons
Ballast—S. F. loop and Pier W-4	13,766.73	tons
Laying double track—East Bay Crossing	10,247.00	linear feet
Laying double track—West Bay Crossing	10,304.00	linear feet
Laying double track—Yerba Buena Island	1,798.00	linear feet

Costs

COSTS

Amount of contract items	$521,412.25 *
Total extra work orders	9,741.03
Total paid to contractor	$531,153.28

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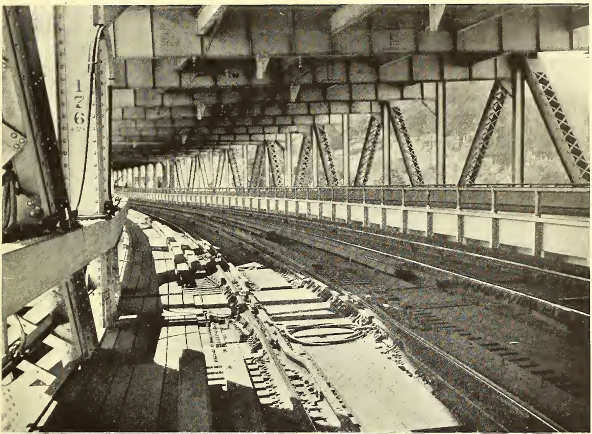
* This sum includes cost of painting structural steelwork; tracklaying in San Francisco loop and contact rail and protection for main Bridge and San Francisco loop.

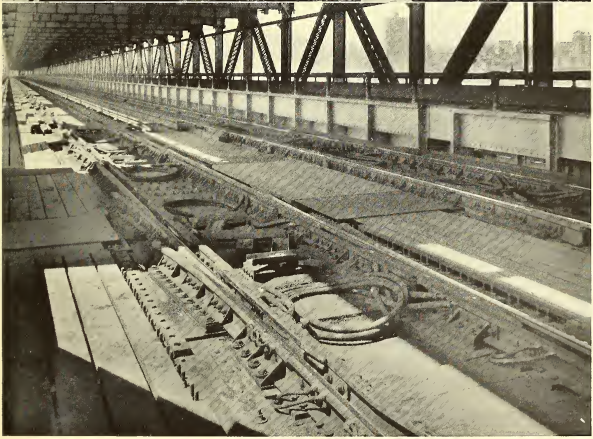
Personnel

J. A. Ginella was superintendent for the Pacific Bridge Company.

Harry Carter was resident engineer for the State.



Single Expansion Joint on a Curved Track



Double Expansion Joint

Adjusting a Crossover for the Catenary System, August 20, 1938

Power Distribution System

⟦Contracts Nos. R-10; R-21C; R-11; R-21B⟧

The contracts under this heading comprise the catenary and feeder systems for the Bridge and San Francisco loop (Contract R-10) and for the East Bay Yard (Contract R-21C); bonding for the Bridge and San Francisco loop (Contract R-11) and for the East Bay Yard (Contract R-21B).

These were described in the Fifth Annual Report.

Status of Work, June 30, 1938

Progress on these contracts was contingent to a major degree on track laying operations. At the beginning of the fiscal year, catenary construction was six per cent completed. A total of 33,400 feet of main messenger and 20,400 feet of intermediate messenger and contact wire had been strung.

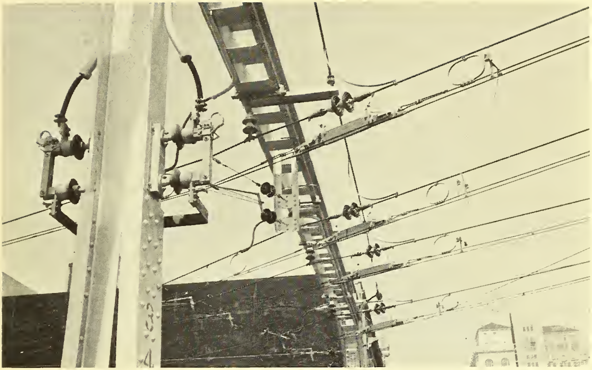
Bonding operations were thirty-one per cent completed.

Catenary Construction

Main Messenger Strung in Sections

Suspension insulators were hung from beam clamps at designated locations, and snatch blocks then attached. Following this operation the main messenger was strung in entire sections from dead end to dead end and pulled to a tension twenty-five per cent above maximum loaded working tension. It was allowed to remain thus for forty-eight hours so that as much stretch might be taken out before loading as possible.

Following this procedure, the messenger was slacked down to a tension which, when the balance of the catenary was added, would produce the desired pull.



Catenary Sectionalizing, San Francisco Viaduct

Hangers were then placed according to requirements. At the bottom end, iron wire hooks were attached for the support of the intermediate and contact wires which were strung in as the following operation and pulled to over-tension as in the case of the main messenger, except that the time limit was reduced to not less than four hours, usually overnight.

The wires were then slacked off to the proper tension, placed in permanent hangers and clipped on. As the messenger was uniformly loaded it was taken out of the snatch blocks and placed in the suspension clamps as part of the hanger erection.

During the stringing operations, temporary pull-offs were placed where required. These were usually snatch blocks fastened with wire or rope anchors.

Catenary Dressing

Final dressing of the catenary was held up until all stringing was completed throughout as great an area as possible. Dressing included the placing of span wires, span wire steadies, pull-offs, section insulators, jumpers, taps and spreaders at catenary crossings.

The winch on the reel car was used for preliminary tensioning. Final tension was accomplished by handle-operated, ratchet chain hoists in one, three and six-ton sizes. All heavy pulling was done by these hoists, with rope tackle used for long movements and light pulls.

CATENARY EXPANSION

Expansion was provided for the catenary at all major Bridge expansion joint locations. (Refer also to Volume V.)

The catenaries were dead-ended to the end floor beams of the stiffening trusses on each side of the joint. A copper contact bar was supported between these floor beams; which allowed the contact wire to slide under the bar at one end or to travel with the contact bar at the other.

To prevent objectionable impact and sparking by the pantograph at these points, two spans of contact wire were strung and dead-ended to the floor beam at one end and attached to counterweights on the other to produce a tension of 1500 pounds to each wire.

Counterweigths for Catenary Construction

The transition from the main contact wire to the expansion span was thus made gradual. Tensioned by the counterweights, the sag for the catenary expansion is entirely independent of Bridge movements arising from temperature or loading. The counterweights are mounted in guides on the Bridge vertical members and connected to the contact wires through sheaves and equalizer blocks provided with standard hoisting cable.

OTHER CONTRACT ITEMS

The other items involved under Contracts R-10 and R-21C included also installation of the feeder system; erection of tie stations; connections to substations; connections to contact rails; and the connection from negative rails to substation negative buses. (Refer to Volume V.)

Progress

Wherever possible, work was projected at various points and in coordination with track operations.

At the beginning of the fiscal year, work was under way on the expansion cables at Piers W-1 and W-4 while construction of conduits for the tie station at Pier E-7 had been started and the erection of the Yerba Buena Island tie station was in progress.

Simultaneously catenary stringing operations in the East Bay Yard were well under way.

Early in August 1938 stringing of the catenary on the Bridge started. By August 21 the catenary servicing the mainline tracks in the East Bay Yard was ready for the operation of Key System trains to the trestle. These trains were rerouted on that date from the old tracks. (Refer also to page 58.)

At this time both contracts were completed to a total of twenty-six per cent.

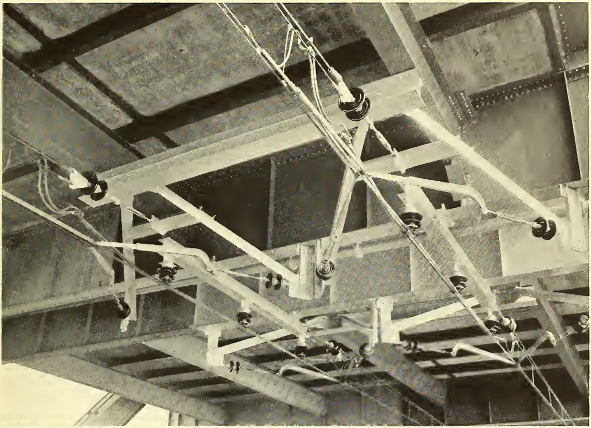
Approximately one month later the catenary had been installed on the Bridge to the extent that a test run was made by a Key System train from Pier E-23 to Pier W-1, running on 600 volts. (Refer also to page 35.) By October 8 the catenary of the north track of the Bridge was completed and energized to allow the Interurban Electric to make its first test run, operating on 1300 volts.

Catenary for San Francisco Viaduct

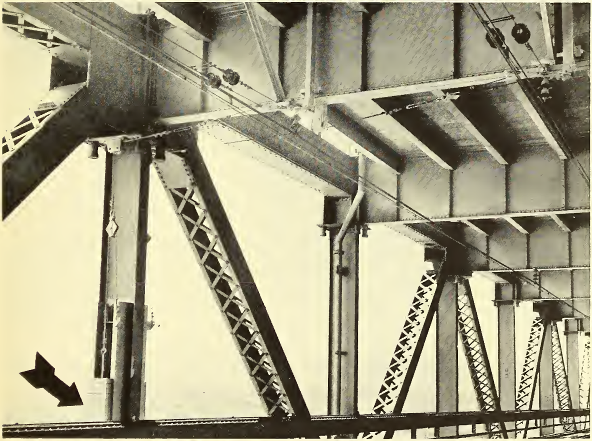
Major work in erection of the catenary for the San Francisco loop started late in October, and continued rapidly so that on Saturday, December 17, 1938, the catenary for the eastbound loop section was energized to permit an Interurban Electric train to run into the Terminal. On the preceding Wednesday, the contact rail had been energized on the Bridge and a Key System train operated under this power from the easterly end of the Bridge to the Sterling substation in San Francisco. (Refer also to page 35.)

Remaining work was accomplished simultaneously with test operations made by Interurban Electric trains.

By Sunday, January 15, 1939, the two contracts were eighty-five per cent completed, but the minor work remaining to be done did not interfere with the start of operations of the Bridge Railway on that day. (Refer to page 65.)



Catenary Expansion Joint



Counterweight for Catenary Expansion (Note Arrow)

The balance of the work centered in the East Bay Yard where catenary stringing operations continued for the storage tracks. By March 25, 1939, Contracts R-10 and R-21C were completed.

Bonding

All bonds placed under Contracts R-11 and R-21B were welded with an oxygen-acetylene flame using a special copper alloy rod to give a uniform bond between the copper bond and the steel rail. The bonds, as furnished, are formed of fine copper wire to give maximum flexibility.

A thin copper sleeve, placed around the end of the bond, served as a cushion and protected the wires from the steel sleeve which formed the terminal proper, and allowed the weld metal to form a uniform contact between all of the wires and the steel rail. The majority of the bonds, which varied for the most part only in length and size, were attached to the ball of the rail on the side away from the wheel flanges.

Running Rail Joints Bonded

All running rail joints were bonded for negative return except at impedance bonds, where insulated joints had been installed. Wherever guard rails were used the joints were similarly bonded and connections were made at designated locations to the neutrals of the impedance bonds in the running rails. Similar bonds were used for all fifty-five-pound contact rail joints; for expansion joints in the one-hundred-and-fifty-pound contact rail and, wherever required, for the attachment of cross bond and jumper cables.

Negative Bonding

All negative bonding at turnouts was made with bare bonds in suitable lengths stapled to the ties every two feet. Bonds which ran parallel to the rails were stapled on top of the ties four inches in from the rails. Bonds parallel to the ties were stapled to the side of the tie two inches below the top edge.

Cross bonds between tracks in the East Bay Yard have a rubber insulation and non-metallic parkway covering and were installed in trenches which extended below the ballast. Where this type of bond was installed on the Bridge, rubber and braid insulation was used and the conductor strapped or stapled to the ties.

Rubber and Braid Insulation

All positive insulated bonds have a rubber and braid insulation which is covered with a sixty per cent tough rubber jacket for mechanical protection. Expansion joint jumper bonds were protected by boxing parallel to the protective trunking on the side away from the track. Bonds that crossed the tracks were protected by redwood trunking at the same height as the ties.

Pin bonds were installed at the heel of each switch. These bonds were inserted in holes drilled through the web of the rail.

The one-hundred-and-fifty-pound contact rail was electric welded into continuous sections up to 1500 feet and bonded with solid copper bonds.

After welding, all rail surfaces were cleaned and polished with an emery wheel and holes then drilled to match those in the bonds. The ends of the rail were heated by kerosene blow torches and the surfaces tinned. One bond was placed at each side of the rail and bolted into position with all edges soldered to the rail.

The fifty-five-pound rails were joined together with angle bars and bonded with two eleven-inch 4/0 bonds attached to the ball of the rail.

At the rail expansion joints on the Bridge, where there was an appreciable rail movement, the bonds between adjacent sections were placed in loops. They are made from 350,000 c.m. insulated conductors thirteen feet or seventeen feet long, two to a joint. The loops were piled one above the other between the rails. Oil-proof rubber jackets were provided for the protection of these bonds from grease and oil.

Progress

At the end of the first week of the fiscal year, welding of the contact rail joints on the Bridge had been completed, except for minor gaps, from Pier E-22 to Pier E-4. In the East Bay Yard welding of contact and running rail joints and other miscellaneous items was well under way.

Bonding Work Completed

By December 17, 1938, practically all bonding work under Contract R-11 had been finished and Contract R-21C was ninety-one per cent completed. Both contracts were completed by January 28, 1939.

Summary

Contracts R-10 and R-21C were awarded to Barrett and Hilp of San Francisco and T. L. Rosenberg of Oakland February 2, 1938, on a low bid of $370,283. Work started February 21, 1938, and was completed on March 17, 1939. Contract R-10 was accepted March 28, 1939, and Contract R-21C was accepted April 7, 1939.

Contracts R-11 and R-21B were awarded to the General Welding Company of San Francisco September 24, 1937, on a low bid of $32,527.05. Work started January 20, 1938, and was completed January 31, 1939. The contracts were accepted March 2, 1939.

QUANTITIES

⟦Contract No. R-10⟧

Disconnect switches, 1200 amp., Type K	12
Reinforcing feeder cable	3,557.5 linear feet
Miscellaneous iron	17,362 pounds

COSTS

Costs

Amount of contract items	$192,594.24 *
Total extra work orders	25,008.16
Total paid to contractor	$217,602.40

* This sum includes cost of feeder cables, San Francisco substation and Island substation and tie station; W-4 tie station; Island tie station building and equipment; E-7 tie station; disconnect switches, Type R; jumper cables at Bridge expansion joints; overhead construction; and power line to San Francisco Terminal.

QUANTITIES

⟦Contract No. R-21C⟧

Disconnect switches, 1200 amp., Type H	7
Disconnect switches, 1200 amp., Type B-SPDT	6
Miscellaneous iron	22,373 pounds

COSTS

Amount of contract items	$174,447.44 *
Total extra work orders	14,835.45
Total paid to contractor	$189,282.89

* This sum includes cost of feeder cables at mole substation; yard tie station; east end tie station; disconnect switches, 1200 amp., Type R; connections 600-volt overhead; overhead construction; and power line to inspection buildings.

QUANTITIES

[Contract No. R-11]

13½″-250,000 C.M. bonds	12,922
250,000 C.M. bonds at special trackwork	106
350,000 C.M. bonds, lengths 3 to 6 ft.	852
350,000 C.M. bonds, lengths 7 to 19 ft.	428
350,000 C.M. bonds, lengths 20 to 40 ft.	48
No. 2 A.W.G. bonds	168
Negative feeder taps	152
1,000,000 C.M. jumper cable	4,381 linear feet
500,000 C. M. cross bond cable	6,087 linear feet
Weld and bond 150-lb. contact rail joint	1,159 joints
11-inch 4/0 bonds	1,146
1,000,000 C.M. cone terminals	158
500,000 C.M. cone terminals	19
Spark gaps and connections	8 units
500,000 C.M. contact rail jumpers, 8 to 16 ft.	382
500,000 C.M. contact rail jumpers, 16 to 38 ft.	90

COSTS

Amount of contract items	$19,195.88
Total extra work orders	11,001.28
Total paid to contractor	$30,197.16

QUANTITIES

[Contract No. R-21B]

13½-250,000 C.M. bonds	11,171
250,000 C.M. bonds at special trackwork	226
350,000 C.M. bonds, lengths 3 to 6 ft.	686
350,000 C.M. bonds, lengths 7 to 19 ft.	258
350,000 C.M. bonds, lengths 20 to 40 ft.	92
Negative feeder taps	88
1,000,000 C.M. cross bond cables	1,811 linear feet
Structure grounding bonds to ground rods	52 units
Structure grounding bonds to yard rails	72 units
Welding and bonding 150-lb. contact rail joint	242 joints
11-inch 4/0 bonds	188
1,000,000 C.M. cone terminals	8
500,000 C.M. cone terminals	11
500,000 C.M. contact rail jumper cables, 8 to 16 ft.	59
500,000 C.M. contact rail jumper cables, 16 to 22 ft.	20

COSTS

Amount of contract items	$12,363.61
Total extra work orders	3,829.54
Total paid to contractor	$16,193.15

Personnel

R. A. Lee was general superintendent in charge of Contracts R-10 and R-21C for the contractors.

C. J. Bergundthal, partner-owner of the contracting company, was superintendent for the contractors on Contracts R-11 and R-21B.

Henry M. Tilson was resident engineer for the State on these contracts.

Terminal Building Additions

⟦Contract No. R-12⟧

After the start of the Bridge Railway, experience indicated the necessity of certain additions to the San Francisco Terminal facilities to permit more efficient operation and to provide greater safeguards.

Among these items were the following:

1. Third rail protection throughout the Terminal.
2. Track destination signs.
3. Power cables—Sterling substation to the Terminal.
4. Train starting lights.
5. Elevation of the control board for the destination signs to improve operator's vision of all incoming trains.
6. House for maintenance tools on Rincon Hill.
7. A work shop in the Terminal.

Control Board Elevated

Many of these operations were located over and adjacent to operating tracks. To avoid division of responsibility, the California Toll Bridge Authority arranged to have these miscellaneous items done by Key System forces. This work was completed at a cost of $15,739.54.

East Bay Yard—Track Work

⟦Contract No. R-21A⟧

This project was described in the Fifth Annual Report. Items included under this contract involved the placing of imported fill, preparation of subgrade, installation of a drainage system, placing of ballast and trackwork in the East Bay Yard.

It also included the construction of concrete foundations for the inspection buildings and other structures in the Yard, and the complete erection of the signal tower. The timber piling for the Administration Building annex (refer to Contract 20, page 67) was placed by an extra work order under this contract.

Timber Piling for Annex

Status of Work, June 30, 1938

At the beginning of the fiscal year, but one per cent of all imported fill remained to be placed; forty-four per cent of the ballast had been laid; and track operations were half completed.

Construction Progress

Work was completed sufficiently in the Yard by August 21, 1938, to permit the transfer of Key System operations from the company's old tracks to the new mainline tracks of the Bridge Railway west of the Key subway and east of the pier (refer also to pages 35 and 52).

At this time subgrading for the entire Yard was within twenty per cent of completion, the installation of the drainage system was eighty-five per cent completed and tracklaying operations, seventy-six per cent completed.

Inspection Building Foundation Completed

Foundations for the Interurban Electric inspection building and shoe pit were completed by the end of October, and all work on the Key System inspection building finished except for the concrete construction, which was thirty per cent completed. This item was finished by the first week in December 1938.

Tracklaying operations, subgrading and drainage work were completed by the first week in January 1939.

Only minor items remained to be finished after the start of the Bridge Railway January 15, 1939, including ballasting and dressing storage tracks, and landscaping.

Summary

This contract was awarded to Bates and Rogers Construction Corporation of San Francisco September 21, 1937, on a low bid of $428,363.75. Work started October 26, 1937, and was completed by March 3, 1939. The contract was accepted April 1, 1939.

QUANTITIES

Framing and placing bridge ties	93.83 M.F.B.M.
Framing and placing other floor timbers	46.06 M.F.B.M.
Excavation	5,188.50 cubic yards
Imported fill	100,736.00 tons
Ballast	102,714.07 tons
Concrete	416.62 cubic yards
Reinforcing steel	19,364.00 pounds
Crusher run base	141.99 tons
Mineral aggregate	751.11 tons
Stone screenings	7.00 tons
Type SC-2 asphalt	4.30 tons
Type MC-3 asphalt	36.60 tons

COSTS

Amount of contract items	$528,421.19 *
Total extra work orders	177,910.85
Total paid to contractor	$706,332.04

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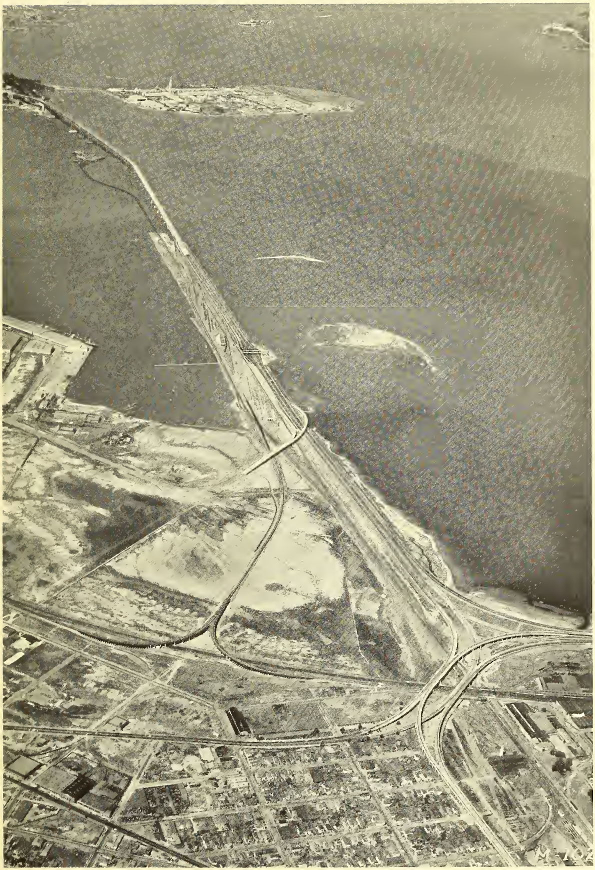
* This sum includes cost of flange protection of steelwork; preparing subgrade; Yard drainage; tracklaying; contact rail and protection.

Personnel

F. L. Copeland, vice president of Bates and Rogers Construction Corporation, and R. Rasmussen, district manager, were in charge for the contractors.

Harry Carter was resident engineer for the State.



Aerial View, East Bay Railway Facilities

East Bay Yard—Key System Work

⟦Contract No. R-21⟧

A description of the work included under this contract was given in the Fourth and Fifth Annual Reports.

Status of Work, June 30, 1938

Work was approximately ninety-five per cent completed at the beginning of the fiscal year, including those items involving removal and relocation of feeder lines and catenary, and signal and telephone cables having to do with the transfer from the existing Key System to the Bridge Railway tracks.

Construction Progress

Abandoned Catenaries Removed

Following the cut-over August 21, 1938, from the old tracks to the Bridge Railway's westbound lines, operations under this contract were concentrated mainly on the removal of the abandoned catenaries and signal lines in order to permit work to proceed under other East Bay Yard contracts.

The contract was completed except for minor items by January 20, 1939, when a Key System crew removed the catenary and feeder taps from temporary westbound lines to the Key pier, abandoned after start of the Bridge Railway January 15.

Summary

Work started May 1, 1937, and is scheduled for entire completion by the middle of August, 1939. Cost of this project is $359,985.06.

Personnel

S. G. Culver, chief engineer of the Key System, is in charge of the work for the company. Harry Carter is resident engineer for the State.

Southern Pacific Connections

⟦Contract No. R-22⟧

Interurban Facilities Relocated

Work on this project was well under way at the beginning of the fiscal year.

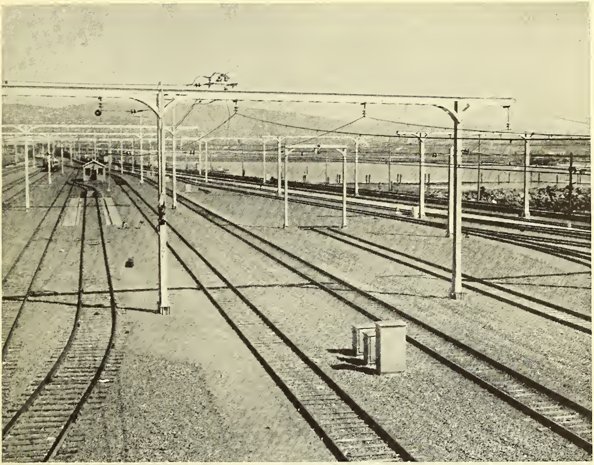
Southern Pacific forces employed included catenary, signal, bonding, telegraph and track crews. The work involved the relocation of those existing Southern Pacific interurban facilities at the 26th Street Overhead and the installation of new equipment necessary to the operation of the Bridge Railway.

Work started on this project June 8, 1937, and all major operations had been completed by the end of November, 1938. Minor adjustments are practically finished, with the termination of the entire project schedule for the end of July, 1939.

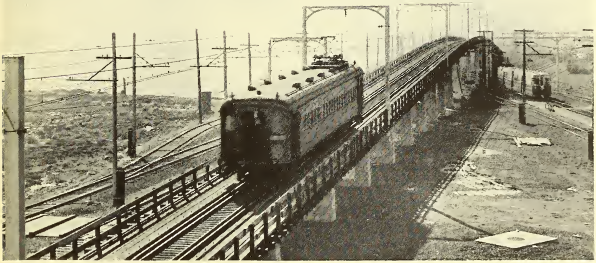
Final contract payment will amount to $270,117.52.

Personnel

B. J. Hogan, assistant division engineer of the Southern Pacific Company, is in charge of work for the company. Harry Carter is resident engineer for the State.



Train Yard, Looking East



Interurban Electric Overhead, East Bay Yard

Seventh Street and Alameda Connections

⟦Contract No. R-24⟧

This project, executed by Southern Pacific forces in agreement with the State, had been surveyed and graded at the beginning of the fiscal year.

Signal, catenary and track crews finished the work in time for operation of the Bridge Railway. Minor adjustments were continued to April 26, 1939, when the project was completed, at a cost of $90,589.04.

Personnel

The personnel directing operations on this project for the Southern Pacific Company and the State was identical with that in charge of Contract R-22.

Alterations and Additions to Rolling Stock

⟦Contracts Nos. R-30; R-31; R-32⟧

These contracts were discussed in the Fifth Annual Report.

Work on the Interurban Electric Railway Company's equipment (Contract R-30) was thirty-eight per cent completed at the beginning of the fiscal year. Alterations were finished in time for the start of operations across the Bridge, January 15, 1939.

The work was done by Southern Pacific forces under the direction of Assistant Master Mechanic L. A. Mitchell. Final payment on this contract amounted to $1,165,521.95.

Key System required new rolling stock, acquisition of which, in so far as State participation was involved (Contract R-31), was completed during the last fiscal year. State purchase of equipment, which was leased back to the Key System, amounted to a total expenditure of $2,470,000.

Sacramento Northern Railway Agreement

A contract between the California Toll Bridge Authority and the Sacramento Northern Railway (Contract R-32) was executed September 22, 1938. This agreement provides for necessary alteration to the company's cars which would permit operations across the Bridge, mainly with respect to signal equipment.

Alterations to seventeen motor cars were involved. Work was completed in time to permit the railroad company to start revenue operations January 15, 1939.

Total cost of the contract was $80,690.

Opening of the Bridge Railway

Contracts for the Bridge Railway were completed sufficiently to permit the start of operations Sunday, January 15, 1939, although the facilities were officially transferred to the use of the interurban companies at formal ceremonies held in front of the San Francisco Terminal Saturday noon, January 14.

Two Key System seven-unit trains carried the official party of some fifteen hundred persons across the Bridge from the City of Oakland into the Terminal. State officials, Federal representatives, members of the State Legislature, mayors and dignitaries of San Francisco Bay cities and many from northern California; railroad executives, contractors and labor representatives were among the guests.

The ceremonies took place on the streetcar ramp before the Terminal. A public address system carried the speakers' words to the crowd of spectators that overflowed the Plaza.

Director Clark
Declares Rail
Facilities Completed

Director of Public Works Frank W. Clark formally declared the rail facilities completed for operation and recommended acceptance by the California Toll Bridge Authority. Ellis E. Patterson, Lieutenant Governor, accepted the project on behalf of Governor Culbert L. Olson, chairman of the California Toll Bridge Authority.

The Lieutenant Governor then formally transferred the facilities to the operation of the railroads with these words:

"In accordance with the agreement between the California Toll Bridge Authority and Interurban Electric, Key System and Sacramento Northern, I formally place the use of these railway facilities in the hands of representatives of the railroads here today. I am certain, gentlemen, that it will be your policy to operate these facilities to the best interest of the public."

Acceptance of the facilities was made by A. T. Mercier, president of Interurban Electric; Alfred J. Lundberg, president of Key System; and H. A. Mitchell, president of Sacramento Northern.

Speakers included Chief Engineer C. H. Purcell; Howard J. Klossner, director of the Reconstruction Finance Corporation; F. M. McAuliffe; and Frank C. MacDonald, General President of the State Building and Construction Trades Council of California.

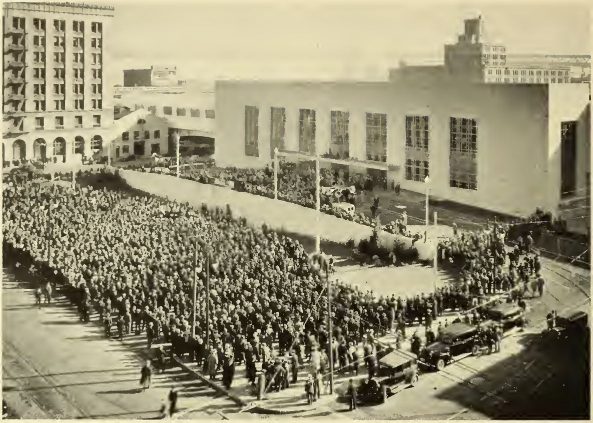
Chief Engineer Purcell
Lauds Workmen

Mr. Purcell said: "Into this project have gone the skill and experience of the engineering profession—civil, electrical and mechanical. Great praise is due the staff of engineers employed by the State Department of Public Works on design and in the field, and particularly to Charles E. Andrew, Bridge Engineer, and to Glenn B. Woodruff, Engineer of Design, who worked faithfully, conscientiously and ably.

"The fine cooperation of the American workmen employed on the project; of the contractors engaged in construction of the facilities; and of the railroads that will operate the system deserves high tribute. Our deep appreciation is given to the Federal Government through the Reconstruction Finance Corporation, and to the City and County governments of the Bay area for the invaluable aid rendered us."

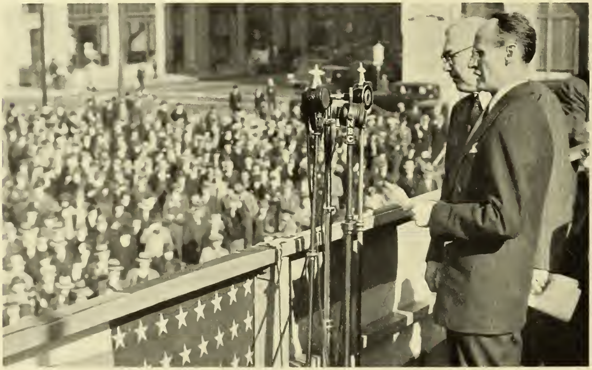
Mr. McAuliffe read a telegram from Jesse Jones, chairman of the Reconstruction Finance Corporation, as follows:

> "C. H. Purcell, Chief Engineer
> "Department of Public Works
>
> "I wish very much that I could be present at the dedicatory ceremonies starting interurban service on the San Francisco-Oakland Bay Bridge. Again I am reminded that the design and construction of this Bridge is one of outstanding engineering feats of our generation. It is beautiful, as well as being of great service, and will stand a credit to all who had part in the great achievement. I extend hearty congratulations to San Francisco, Oakland and California.
>
> JESSE H. JONES, *Chairman.*"



Dedication Ceremonies of the Bridge Railway Facilities, January 14, 1939

Mayor Angelo J. Rossi of San Francisco greeted the mayors of the neighboring cities who participated in the ceremonies. Replies were made by Dr. William McCracken, Mayor of Oakland; Edward N. Ament, Mayor of Berkeley; Henry A.



Director of Public Works Frank W. Clark (left) and Chief Engineer C. H. Purcell at the Dedication Ceremonies

Weichhart, Mayor of Alameda; Oliver Ellsworth, Mayor of Piedmont; Earl Derry, Mayor of San Leandro; and T. B. Monk, Mayor of Sacramento.

Supervisor John Ratto of San Francisco, chairman of the Citizens' Committee, for the opening ceremonies of the Bridge Railway, presided at the dedication.

The Terminal was thrown open for public inspection at the close of the formalities.

Start of Revenue Operation

Although the ceremonies were completed, the actual work of connecting the existing interurban lines of the operating companies to the Bridge tracks remained to be accomplished. It involved the connection of power, rails and signal facilities at the easterly Bridge end; at the 26th Street Overhead; at Seventh Street; and at Lincoln Junction in Alameda in a period of time limited by the operation of the last train over the old systems and the first train into San Francisco over the new facilities approximately four hours later.

So close was the margin of time that the connections were completed at the east Bridge end and the system energized with only four minutes to spare before the Interurban Electric's 7th Street Line, leaving San Leandro at 4:48 a.m., entered the Bridge at approximately 5:37 a.m.—the first revenue train to operate over the Bridge Railway.

First Revenue Train

The ten-car train was jammed with several thousand persons ambitious to be among the first to cross the Bridge. It passed hundreds of persons at wayside stations and was cheered by workmen silhouetted against blazing fires at junction points where connections had just been completed. It pulled into the San Francisco Terminal at 5:53 a.m.—less than three minutes late.

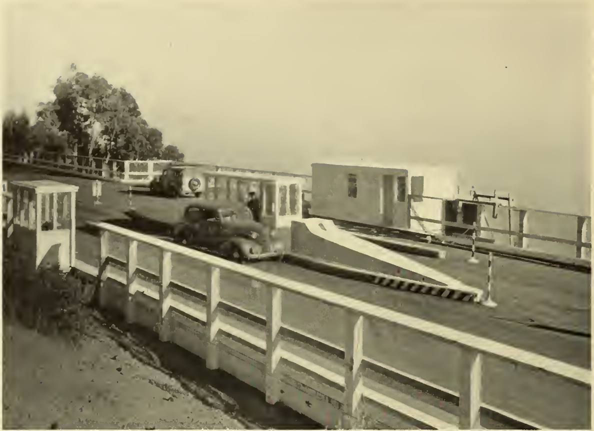
First revenue Key System train entered the San Francisco Terminal at 6:17 a.m. and the first Sacramento Northern arrived at 7:46 a.m., the first direct train connection between northern California and San Francisco.

Toll Plazas, Yerba Buena Island

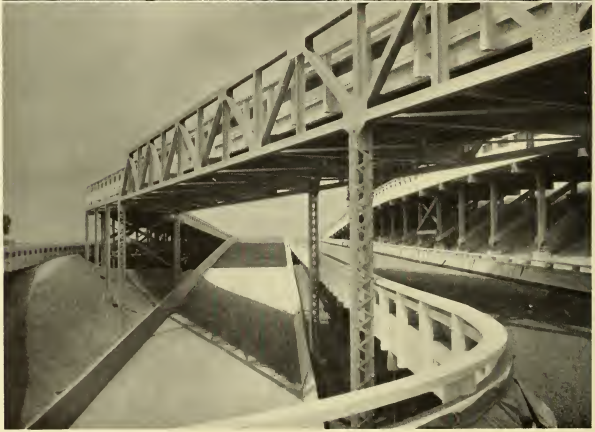
[Contract No. 19]

The layout of Yerba Buena Island connections with Treasure Island was made by the Exposition authorities in cooperation with Government authorities on the Island and referred to the California Toll Bridge Authority's engineers. (Refer also to Volume V.)

The connections comprise one from each side of the upper deck and one from the north side of the lower deck. They were designed on the basis that only the lower deck connection was to be permanent. This roadway will continue to serve Treasure Island when it becomes an airport. The upper deck connections are to be removed upon the closing of the Exposition.



Toll Plaza for
Exposition Traffic,
Yerba Buena Island



Ramps Segregating
Exposition Traffic

Provisions for toll collection from Treasure Island-bound motorists made it necessary to install toll-collecting stations on the upper deck connection and a permanent station on the lower deck.

Toll Collection for Exposition Traffic

Only truck traffic is permitted to use the lower deck roadway during the course of the Exposition. Here the toll station comprises two booths of steel construction and an office. This installation also includes a sixty-foot scale similar to those installed at the main Toll Plaza. There are four toll lanes.

The upper deck toll plaza has four toll lanes, three toll booth structures and an office. These are constructed of timber.

The contract for this work was awarded to Barrett and Hilp on a low bid of $14,900, July 29, 1938. Work started August 10, 1938, and the contract was accepted November 16, 1938.

Personnel

Gerald Hogan, superintendent, and Carl Welmitz were in charge of the work for the contractor.

D. W. Marsh, under the direction of Associate Bridge Engineer C. S. Hamilton, was in charge of the work for the State.

Administration Building Annex

⟦Contract No. 20⟧

Increased accounting and bookkeeping requirements for Bridge administration and the need for enlarged quarters for the personnel and equipment of the California Highway Patrol required additional space for the Bridge maintenance and operation facilities.

It was decided to construct a separate building east of the present Administration Building at the Toll Plaza. Plans called for a one-story building with basement, fifty-six feet and seventy-six feet in plan, which would follow the architectural design of the main structure.

New Patrol Quarters

The ground floor will contain the Patrol captain's office, business office, sergeant's room, conference room, squad room and camera and radio rooms. There will also be a garage for motorcycles and squad cars.

A general file room is included in the ground floor design, and the entire basement will be available for filing space.

Piling for this structure was driven under an extra work order under Contract R-21A.

The contract for the annex was awarded to D. W. Nicholson of Oakland on a low bid of $57,480 March 18, 1939. Work started April 4, 1939.

Personnel

Frank Matzoll is in charge of work for the contractor.

N. W. Reese is resident engineer for the State.

Maintenance Buildings

[Contracts Nos. 21 and 22]

Bridge painting maintenance requirements became such that a building on each side of the Bay was necessary to house personnel, equipment and supplies.

Accordingly, suitable buildings were constructed in San Francisco on Beale Street between Bryant and Harrison Streets and in Oakland at 34th and Wood Streets.

San Francisco Maintenance Building (Contract No. 21)

The San Francisco structure is a single-story reinforced concrete and brick building, twenty-one feet four inches by seventy-two feet nine inches. It contains office, locker and wash rooms, a storeroom for supplies and an equipment room.

Storeroom for Paint Supplies

The contract was awarded to the Empire Construction Company of San Francisco on a low bid of $7,647 May 15, 1939. Work started May 29, 1939. The structure is expected to be completed by the end of July, 1939.

Personnel

N. W. Reese is resident engineer for the State.

Oakland Maintenance Buildings (Contract No. 22)

The Oakland maintenance building project involved the job of remodeling. The site acquired by the State in connection with the Bridge Railway facilities was occupied by a single-story brick warehouse forty feet by sixty-five feet and an office building twenty feet by twenty-five feet in plan. In addition a frame building twenty-six feet by forty feet had been constructed by the State as headquarters for the engineers supervising east side construction of the railway facilities.

Old Building Remodeled

The contract called for the construction of a concrete foundation for the wooden building, a new roof and a stucco exterior. Included in the contract was an item for fencing the California Toll Bridge Authority's right of way adjacent to the 26th Street Overhead.

The contract was awarded to Barrett and Hilp of San Francisco on a low bid of $11,435 May 15, 1939. Of this amount the fencing item was $6,700. It is expected that the project will be completed by the end of July, 1939.

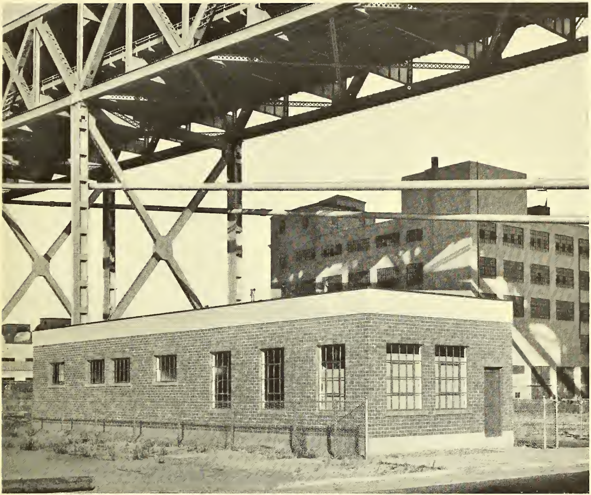
Personnel

Harold L. Morian, Junior Bridge Engineer, is in immediate charge for the State under N. W. Reese, resident engineer.

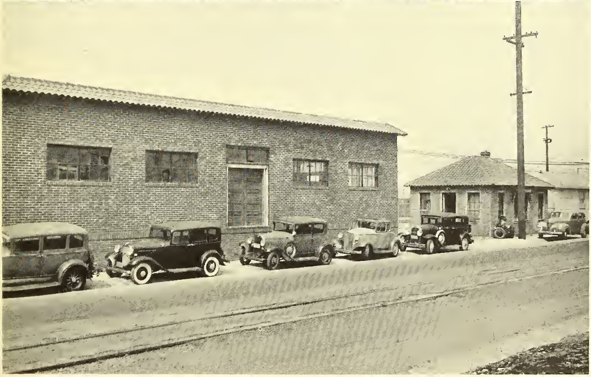
Legislative Approaches

Status of Work June 30, 1938.

The location, financing and construction of the Legislative Approaches to the Bridge have been completely described in previous reports (Volumes I to V). On June 30, 1938, the only remaining work to complete consisted of landscaping the eastern approach which was well under way.



Painting Maintenance Building, San Francisco



Painting Maintenance Buildings, Oakland

Watering Systems, Curbs and Shoulder Widening—Contract 84TC15-84WC6

Redwood Curbs Installed

The work done under this contract, which was approximately sixty per cent completed at the beginning of the fiscal year, consisted, in general, of constructing redwood curbs, installing a water supply pipe line, and widening shoulders. Parking areas were to be graded, penetration oil and screenings applied to the shoulders and parking areas. Brass hose gate valves, hose bibbs and risers, check valves and unions were to be furnished and installed.

While the major portion of the contract was completed during the preceding fiscal year in a short period of time, the balance of the work extended over a somewhat longer period. This was due to the necessity of coordinating the work with the setting of plants by State forces and final completion of the contract was effected on November 7, 1938.

Day Labor Work Order 84T22

At the beginning of the fiscal year the work on this project was well under way. A considerable portion of the area to be planted had been prepared and a major portion of the plants had been assembled on the site of the work with some of the plants in place.

Plants Inspected

All plants received on the project were inspected by the Department of Agriculture Plant Inspection Division, immediately upon delivery. Those plants quarantined by the Plant Inspector, a total of 246, were returned to the shipper or destroyed at his request.

Shrubs and trees, of which there were approximately 12,300 were planted in specially prepared locations. All shrub holes were dug a minimum of two feet in width and two feet in depth. Holes for trees were in general three feet wide and two and one-half feet deep.

The excavated top soil was stockpiled and later mixed with fertilizer. The top six inches of excavated material, on the average, was suitable for planting; the balance of the sub-soil consisted of sand and clay balls which was spread on adjacent areas. Due to the limited amount of suitable top soil available on the project, a sufficient amount was imported from outside sources to prepare properly the holes for planting purposes. After the holes were backfilled with top soil and fertilizer, they were compacted by jetting with water to eliminate settlement after planting of shrubs and trees.

Prior to planting of ground cover plants on the other areas the existing material was graded to a uniform section and disced. The sections in the dividing strips, where there were existing curbs, were first excavated to a depth of two inches below the tops of curb and the material used in areas outside of the shoulder. Fertilizer was then spread over the entire planting area and cultivated into the soil in place; two crops of weeds were allowed to sprout and were removed prior to actual planting.

Ice plant cuttings were then planted by two methods, the first used in the division strips in their entirety was by dibble method with cuttings pressed firmly into the resulting holes. The balance of the area was furrowed, cuttings placed in the furrows and the soil hoed into place, each cutting being firmly embedded by pressure.

Approximately 12.85 acres were planted with 265,500 ice plant cuttings consisting of 210,000 of the mesembryanthemum edule and 55,500 of the mesembryanthemum croceum.

Twelve Acres Planted

An additional area of sixteen acres including the center of the Folger Avenue "Y" and the area under the Distribution Structure was seeded with California poppies for an effective display of color.

Due to operations of contractors engaged in constructing the Bridge Railway facilities the area on the south side of the main approach between the Toll Plaza and the Distribution Structure was excepted from this project. Plans are being prepared for this section for inclusion in the ensuing fiscal year.

The project, completed April 19, 1939, was constructed under day labor by State forces supervised by H. Dana Bowers, Division of Highways landscape engineer, and H. W. Miller, resident engineer.

The progress of the legislative approach projects is under the direction of Colonel Jno. H. Skeggs, District Engineer, District IV, Division of Highways, and under the direct supervision of P. O. Harding, assistant district engineer.

STATUS OF WORK ON LEGISLATIVE APPROACHES TO SAN FRANCISCO-OAKLAND BAY BRIDGE

JULY 1, 1938, TO JUNE 30, 1939

Contract No.	Description	Total Work	Per cent Com- pleted	Contractor
64TC6	Dredger fill	$960,351.49	100	American Dredging Co.
64TCB	Rock wall	279,488.61	100	Fredrickson & Watson & Fredrickson Bros.
64TC16	Pabco subway	26,336.10	100	Healy-Tibbits Construction Co.
64TC24	San Francisco approaches	539,948.05	100	Healy-Tibbits Construction Co.
64TC26-84TC1	Distribution structure	1,180,568.85	100	Barrett & Hilp
64TC29	Folger Avenue underpass	131,800.63	100	J. F. Knapp
84TC2	Lighting approaches	90,169.22	100	Alta Electrical & Mechanical Co. and American Building Maintenance Co.
84TC3	San Pablo underpass	374,443.99	100	J. F. Knapp
84TC4	Mole paving	281,104.69	100	Hanrahan-Wilcox Corp.
84TC8	Ashby Avenue connection	31,368.20	100	L. C. Seidel
84TC9	Landscaping Fifth Street Plaza	16,210.71	100	California Nursery Co.
84TC10	Cypress Street, Thirty-fourth to Seventh	135,215.94	100	Hanrahan Co.
84T8	Lighting distribution structure to Folger Avenue	21,550.38	100	Work done by State forces
84T9	Traffic signs	18,905.61	100	Work done by State forces
84T10	Traffic stripes	1,574.56	100	Work done by State forces
84T2	Propagation of plants	1,838.17	100	Work done by State forces
84T22	Preparing ground and planting	37,344.72	70	Work being done by State forces
84TC15	Water lines, curbs, shoulder widening	13,577.38	100	Williams Bros. & Haas
	Subtotal	$4,142,268.84		
	Engineering	399,200.41		
	Subtotal	$4,541,469.25		
	Property	*1,890,778.95		
	Total	$6,432,248.20		

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* Reduced from previous total by rebate of $215,420.05 from Bay Bridge a/c $480,152.00 in jointly used property.

STATUS OF BRIDGE RAILWAY RIGHT OF WAY ON JULY 1, 1939

	Total Number of Deeds	Deeds executed			
		No.	Net cost (not including rental credits, nor cost of title reports, insurance, engineering, legal expenses, contingencies, etc.)		
			Land	Improvements, etc.	Total
City and County of San Francisco	42	41	$1,191,477.60	$1,791,829.06	$2,983,306.66
Alameda County	14	7	115,519.24	26,503.38	142,022.62
Totals	56	48	$1,306,996.84	$1,818,332.44	$3,125,329.28

STATEMENT OF RECEIPTS AND EXPENDITURES

FROM SEPTEMBER 14, 1932, TO JUNE 30, 1939

RECEIPTS		
Bonds sold to R. F. C.		
Series T. S. R., 4%	$31,700,000.00	
Series T. S. F., 4%	39,300,000.00	
		$71,000,000.00
Interest received from banks		62,393.67
From Revenue fund		1,240,833.33
Series A bonds		650,000.00
Bond premiums		1,065,000.00
		$74,018,227.00
CONSTRUCTION EXPENDITURES		
Vehicular bridge	$54,726,730.49	
Interurban	18,701,983.23	
		$73,428,713.72
Construction fund balance (State Treasurer)		589,513.28
		$74,018,227.00

EXPENDITURES—INTERURBAN

Engineering and design	$789,303.13	
Legal	70,752.41	
Property	3,444,296.91	
Interest and discount	506,099.22	
Insurance	23,871.24	
Administration	142,564.72	
Consulting architects	97,141.86	
		$5,074,029.49

CONTRACT PAYMENTS

R- 1	Demolition	$121,175.00	
R- 2A	San Francisco terminal—general construction	1,859,846.50	
R- 2B	San Francisco terminal—structural steelwork	426,129.83	
R- 2C	San Francisco terminal—mechanical	115,760.77	
R- 2D	San Francisco terminal—electrical	91,121.45	
R- 3	San Francisco viaduct	614,748.15	
R- 4	Substructure—East Bay yard	522,382.90	
R- 5	Signals and interlocking	1,397,020.60	
R- 6	Telephone system—bridge railway	18,733.00	
R- 7	Superstructure—East Bay yard	529,415.26	
R- 8	Inspection buildings	133,349.05	
R- 9	Trackwork and contact rail	531,153.28	
R-10	Overhead and feeders	217,602.40	
R-11	Track bonding	30,197.16	
R-12	San Francisco terminal—additional work	13,456.45	
R-21A	East Bay yard—trackwork	706,332.04	
R-21B	East Bay yard—bonding	16,193.45	
R-21C	East Bay yard—overhead and feeders	189,797.89	
R-21	East Bay yard—Key System	355,204.23	
R-22	Southern Pacific connections	271,472.17	
R-23	Southern Pacific-Santa Fe Interchange yard	29,498.00	
R-30	Interurban Railway—equipment changes	1,169,362.54	
R-31	Key System—equipment changes	2,470,000.00	
R-32	Sacramento Northern—equipment changes	80,690.00	
R-33	Off-line connections	88,425.61	
	Extra work agreements	48,456.55	
	Construction materials	1,580,429.46	
			$13,627,953.74
			$18,701,983.23

EXPENDITURES—VEHICULAR BRIDGE

Engineering	$542,049.22	
Triangulation and survey	252,576.09	
Administration	405,937.20	
Boat operation	123,288.21	
		$1,322,850.72
Consulting engineers		519,780.43
Insurance		434,887.74
Legal		123,022.59
Property		2,161,221.91
Rental Pier 24		90,591.25
Moving cables		110,316.65
Inspection		337,859.60
		$5,100,530.89

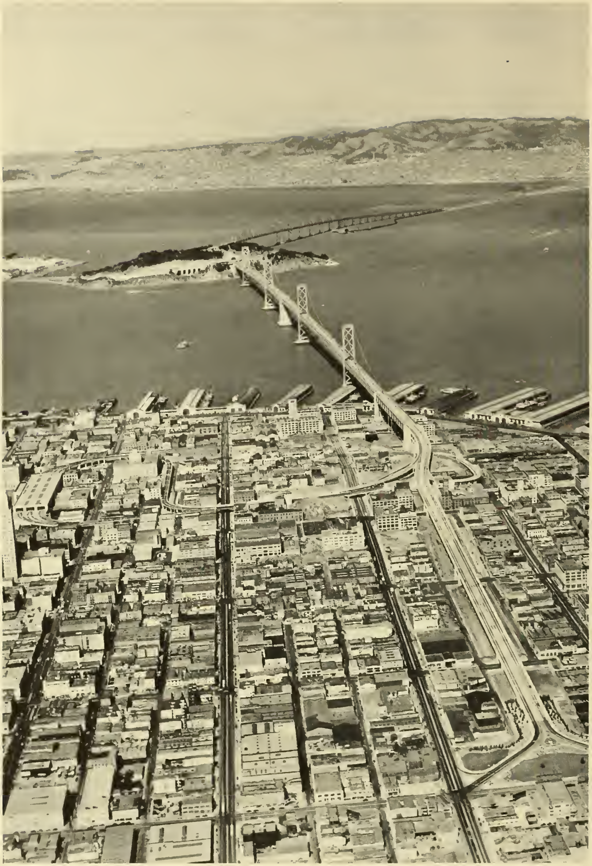
CONTRACTS COMPLETED

1.	Foundation borings	$639,196.61
2.	Substructure West Bay	7,474,759.14
3.	San Francisco anchorage	1,084,247.80
4.	Substructure East Bay	4,580,189.88
5.	Yerba Buena Island crossing	2,352,208.04
6.	Superstructure West Bay	14,484,625.20
7.	Superstructure East Bay	9,219,302.02
8.	Girder spans	263,170.95
9.	Final field painting	887,446.86
10.	Administration building	353,056.27
11.	Electrical work	375,415.19
12.	Traffic signs	4,863.07
13.	Tunnel lining	55,563.87
14.	Island garage	14,476.66
15.	San Francisco section	817,216.63
16.	Operating equipment	109,508.29
17.	Island fencing	7,063.69
18.	Fireproofing outside hazards	155,397.17
19.	Toll Plaza—Yerba Buena Island	15,533.57
20.	Administration building annex	13,626.04
21.	San Francisco maintenance building	1,984.82
22.	Oakland maintenance building	10,087.87
	Extra work agreements	284,078.50
	Field engineering and expense all contracts	775,334.57
	Interest and discount*	5,647,846.89
	Total vehicular bridge	$54,726,730.49

Interest*	$5,131,947.75
Discount	+1,731,482.89
	$6,863,430.64
Rebate— Interest	—1,215,583.75
	$5,647,846.89

. . . PART II . . .

OPERATION AND MAINTENANCE



The Bay Bridge from San Francisco, Showing the Interurban Terminal and Viaduct (left); Fifth Street Highway Approach (lower right)

Operation and Maintenance

During the fiscal year a total of 9,476,705 vehicles crossed the Bridge. Of this number 8,463,411 was normal traffic traveling the full length of the Bridge, while the remaining 1,013,294 vehicles went to the Golden Gate International Exposition on Treasure Island. The normal Bridge traffic decreased 1.6 per cent from the preceding year, while the gross traffic increased 9.5 per cent.

Bridge Traffic On Increase

Bridge vehicular traffic has continued to increase in all classes. Noteworthy is the steady increase in normal Bridge truck traffic with only a very nominal loss of this business by the Southern Pacific-Golden Gate Ferry Company. Since the Bridge opened, the number of truck crossings, exclusive of Exposition truck patronage, has increased almost two and one-half times, while the freight increase has been somewhat greater. If the truck traffic to Treasure Island is considered, this increase is, of course, even larger.

The average daily vehicular traffic for the fiscal year was 25,964 while the peak day occurred Sunday, June 25, when 40,865 vehicles crossed the Bridge.

The Key System, Interurban Electric, and Sacramento Northern electric trains started operations over the Bridge Railway System January 15, 1939, and by June 30 they had jointly carried 9,631,593 passengers.

The total revenues received from vehicular traffic, interurban passengers, rents, interest, and other sources, but not including charges for roadside service, for the fiscal year ending June 30, 1939, amounted to $5,176,541. This money is available only for debt service and the cost of use and occupancy insurance. (Refer to Table VII, page 94, for details of vehicular and interurban traffic and revenues.)

The cost of maintenance and operation of the Bridge, including the premium on multi-risk insurance, is met from State gasoline tax funds and for the past fiscal year this amounted to $514,120.85. (Refer to Table I, page 88.)

Toll Changes

Toll Reduction

During the fiscal year there were two reductions in certain vehicle tolls. The toll on specified Key System buses was reduced January 15, 1939, from $0.75 per bus and driver and $0.05 per passenger to a charge only of $0.025 per passenger. These buses run on regular schedules, handle local passengers only between certain areas in the East Bay and San Francisco, and serve territory not directly reached by electric interurban trains. Prior to the reduction, this service amounted to approximately 6,100 buses and 88,000 passengers per month. After the reduction this increased to approximately 7,700 buses and 107,000 passengers per month. The toll revenue from this traffic has been reduced from an average of approximately $8,975 per month to $2,675.

The cash toll for passenger automobiles and light delivery trucks was reduced June 24, 1939, from $0.50 to $0.40. A corresponding reduction in commutation rates for passenger autos will be made July 1, 1939. The reduction was effected in conjunction with refinancing (refer to page 78) and was in compliance with the provisions of the bond resolution.

This resolution requires that the reduced rates, applied to the traffic for the preceding twelve months (but not including Yerba Buena Island or Exposition traffic), together with other recurring revenues for such period must at least equal the minimum scheduled obligations against revenues for the next succeeding twelve months, plus a margin of twenty per cent of the interest and bond principal payments due for that period. (Refer to Table V, page 92, for Toll Schedules.)

Financing

Serial bonds to the amount of $500,000 were regularly retired March 1, 1939, in accordance with the bond resolution. This left outstanding $32,500,000 of four per cent serial bonds and $40,000,000 of four and one-quarter per cent sinking fund bonds, all in the portfolio of the Reconstruction Finance Corporation.

Governor Olson Arranges Interest Reduction

In May, 1939, Governor Culbert L. Olson authorized Mr. Frank W. Clark, Director of Public Works, Mr. Herbert W. Erskine, and Mr. Edward P. Murphy, attorneys for the California Toll Bridge Authority, to proceed to Washington, D. C., as his personal representatives to confer with officials of the Reconstruction Finance Corporation in a proposal for a reduction in interest rate and change in bond maturity in order that a public sale of the bonds could be consummated which would permit of an immediate reduction of tolls over the San Francisco-Oakland Bay Bridge. This desire of attainment was successful, and on June 24th single trip rate was reduced to 40 cents and on July 1st a reduction of tolls on both classes of monthly commutation rates will be effected.

Bridge Bonds Sold to Public

The bonds were sold in June, 1939, to the public through the medium of a syndicate of underwriters. The syndicate paid the Reconstruction Finance Corporation $104 for the bonds and, by previous agreement, the California Toll Bridge Authority received one and one-half points of this profit. This amounted to $1,065,000 for the Authority and was combined with $512,500 from the construction fund to retire $1,500,000 of bonds.

A balance of $71,000,000 thus remains outstanding of which $39,300,000 are sinking fund and $31,700,000 are serial bonds. Included in the provisions of the sale was a reduction in the interest rate on the sinking fund bonds so that all now bear four per cent. The syndicate offered the bonds to the public at 106 and the issue was readily oversubscribed.

In addition to the reduction in interest rate on the sinking fund bonds, the schedule of retirements was changed. (Refer to Table II, page 89.)

Interurban Operation

Interurban train service on the Bridge was inaugurated January 15, 1939. (Refer to page 62.)

Maintenance, Bridge Railway Facilities

The three operating companies, Key System, Interurban Electric, and Sacramento Northern, are responsible for the maintenance of all track and other railway facilities that have been provided by the California Toll Bridge Authority, including the San Francisco Terminal. The Interurban Electric Railway Company maintains the railway facilities west of the Yerba Buena Island tunnel while the Key System is responsible for the facilities through the tunnel and east thereof. Each company maintains its own yard in the East Bay. For the maintenance and operation of the San Francisco Terminal, a separate organization has been created by the three companies and the cost is prorated among them.

For each passenger carried by the interurban systems the Bridge receives $0.025. The Bridge also receives the rental paid by the various concessions in the Terminal. (Refer to page 16.)

In the first five and one-half months of operation the entire system has functioned with no delays except of a minor nature. (Refer also to page 38.) Only nominal repairs have been required in a few places subject to unusual punishment, such as switch points on the very short radius curves adjacent to the Terminal.

Vehicular Competition

Alameda Ferry Route Service Curtailed

The only change in the extent of ferry competition with the Bridge during the year has been in the curtailment of service on the Alameda ferry route. Prior to the start of operation of the interurban trains on the Bridge, interurban passengers and vehicles to Alameda had been carried on the same boats. With the discontinuance of interurban service by this method, the vehicular service was likewise terminated except for trips sufficient only to maintain the franchise. The traffic on this route has now practically disappeared.

The Oakland pier route has continued to carry capacity traffic and last year handled 3,178,180 vehicles. The toll has not changed during the fiscal year. The rate for passenger vehicles was approximately one-half of the Bridge toll, while truck rates were approximately equal.

The Southern Pacific continues to carry its main line railroad passengers and those of the Western Pacific across the bay by ferry. This traffic amounted to 1,283,707 passengers last year. The Santa Fe Railway transports its passengers by special buses operating over the Bridge.

(For comparison of traffic refer also to Table VIII, page 94.)

Exposition Traffic

Prior to the opening of the Golden Gate International Exposition February 18, 1939, a large proportion of the workmen and freight reached the site via the Bridge. Discontinuance of water deliveries of freight in the last weeks before the Exposition opened resulted in very heavy movements over the lower deck of the Bridge.

Bridge Carries Forty-four Per Cent Exposition Visitors

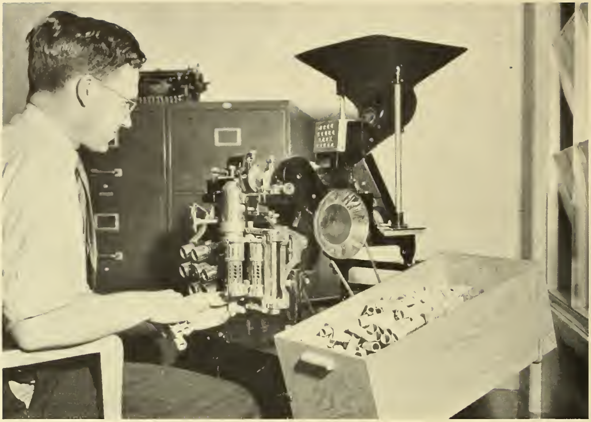
Since the public opening, forty-four per cent of the persons arriving at the grounds between the hours of 9:00 a.m. and midnight came via auto over the Bridge. A total of 16,111 autos made the trip to the Island on Washington's Birthday, February 22, 1939, and this figure was not exceeded during the remainder of the fiscal year.

The problem of handling the volume of traffic without left-hand turns (except on the lower deck), together with the collection of tolls, was effectively solved by a system of ramps on Yerba Buena Island. (Refer to page 65.) The toll collection system was designed to charge the regular one-way Bridge toll for a round trip to the Exposition.

The system has worked without difficulty though the turns on and off the Bridge at Yerba Buena Island are of short radius and must be negotiated at slow speed. However, the capacity of the ramps has always been at least equal to that for handling auto traffic at the Exposition. A record of this traffic is given in Table VI, page 93.

Agreement With Federal Government

The Act of Congress (S. B. 5825, approved February 20, 1931) authorizing the construction of the San Francisco-Oakland Bay Bridge, provided that permission for the right of way across Yerba Buena Island must be secured from the



Coin Wrapping Machine, Teller's Office

Secretaries of War, Navy, and Commerce. This permission was made the subject of a Joint Permit, dated August 20, 1932. It provided for free passage over the Bridge to "military, naval or civilian personnel of the United States, resident, regularly employed or having Government business on the Island or points which may be reached via said Bridge, and to their dependents . . ."

Passes for Government Employees

While there has never been any question relative to free passage for vehicles or persons going to or from the government reservation on the Island, a controversy did arise as to the interpretation of the clause "points which may be reached via said Bridge." This matter was, however, amicably settled by a compromise agreement between the United States Government and the California Toll Bridge Authority, dated December 16, 1938. By the provisions of the agreement, vehicles or persons crossing the Bridge on official government business, regardless of their destination, are accorded free passage. Government employees or vehicles crossing on other than official business pay the regular toll.

All such free passage is obtained only by presenting a properly completed pass to the toll collector. These passes are furnished to the government agencies by the Bridge so that they may be uniform. They are accepted for passage only when signed by an authorized issuing officer and signed again by the user in the presence of the collector.

Operation

Accounting

The work of the accounting department continues under the same general supervision as described in the Fifth Annual Report.

The routine of the cashiers as outlined last year has proved efficient. The reduction of toll fares from $0.50 to $0.40 has increased the complication of the use of the change funds. Some weekends from Saturday to Monday, collectors, in making change, give out as much as $10,000 in dimes. This has necessitated the installation of a coin wrapping machine to obviate sending loose money to the bank in exchange for wrapped coins. The increased revenue from the Fair necessitates the aid of a part-time employee in addition to the regular cashiers.

The regular monthly audit of collectors' and cashiers' funds continues and, in addition, two independent audits of cash have been made, one by certified public accountants and the other by the State Department of Finance.

Interurban Passenger Traffic Compiled

The record of interurban passenger traffic is made by each railroad through its car registers. A certified account is rendered each month by each company and Bridge forces make a monthly audit of the Railroads' register tapes. The record of train passengers is kept separate from the vehicular traffic and is shown in Table VII, page 94.

The additional Treasure Island traffic has necessitated an increase in force of from four to eight accountants to check the traffic records and collectors' deposits and reports. This traffic has increased the statistical work more than proportional to the increase in traffic, due to the necessity of handling thousands of tickets of automobiles returning eastbound from Treasure Island. The Island traffic is segregated for record but is included in the general Bridge traffic record issued monthly.

Toll Collection

Errors in Toll Collection

The traffic to Treasure Island necessitated the placing of collection booths at Yerba Buena Island and the increasing of the toll collection force from forty-three to seventy-two. Five of the experienced collectors were promoted to the position of sergeants. The collectors have maintained their good record; the average net error for the year was $0.0713 per $1,000 cash collected. Thirteen collectors have resigned from the force during the year and have been replaced from the Civil Service list.

Roadside Service

Roadside Service Calls Reduced

The emergency roadside service maintained by the Bridge has operated effectively and efficiently. A total of 6287 services were rendered to Bridge patrons during the year compared with 6466 such services in the preceding year. It is notable that this reduction of 179 in required services was obtained while traffic increased by 803,036 vehicles. An average of 1507 vehicles crossed the Bridge for each vehicle requiring service. This compares with an average of 1341 vehicles for the previous year and a total average of 1354 since the Bridge opened November 12, 1936. Roadside service data is summarized in Table X, page 96.

Traffic Scene, Main Toll Plaza

Truck, Bus and Interurban Traffic, Lower Deck

Maintenance

Electrical

SODIUM VAPOR LIGHTING

Weathering of sodium vapor luminaire reflecting surfaces has continued to cause concern. The Bridge forces are now reconditioning these surfaces with a process that promises to be quite satisfactory.

Luminaires Treated

All reflecting surfaces are brought in to the shop in order that dirt and corrosion can be completely removed. After cleaning, these units are carefully lacquered with methacrylate lacquer before being placed in service again. Several experiments are being carried on by Bridge forces to determine whether other types of lacquer or the addition of several forms of wax will materially retard weathering of these outdoor aluminum reflecting surfaces.

The fiscal year has seen an appreciable increase in sodium vapor lamp life, largely due to the use of portable generator testing apparatus installed on the tower trucks. (Refer to Volume V.) As anticipated, the average life of lamps before replacement has risen to 2296 hours as compared to 2125 hours during the 1937-38 fiscal year, or an average increase of one hundred seventy-one hours per lamp, representing an annual saving to the State of $610 for the 1937-38 fiscal year. A saving of $197 in purchased electrical energy formerly used for testing purposes added to this figure, brings the previous year's saving to $807 as a result of using portable testing generators. Table No. XI, page 96, summarizes sodium vapor lamp operation and replacements for the fiscal year.

DIAL CONTROL

Early in the year, the necessity for increased communication, indication, and control facilities became apparent. A dial switching system was adapted to the peculiar needs of the Bridge distribution system and, as a result, all switching is now accomplished over a single pair of number sixteen gage wires.

Two-motion switches are mounted, together with required relays, in each substation, all simultaneously stepped up by a standard telephone-type dial placed at the telephone switchboard in the Administration Building. Operation of a particular circuit requires only that the proper serial number be dialed in the conventional manner. Grouping relays make it possible to light the entire Bridge and approaches by dialing two numbers. Increased flexibility of switching, the release of wires for other usage and the addition of controls to supplement automatic clocks were made possible as a result.

FIRE PROTECTION

Abnormal temperature units have been installed in all electric substations and in several locations in the Administration Building. These units when actuated, automatically register their code number on the Bridge's fire alarm and tow-car system.

EQUIPMENT

One-man Rig for Electrical Maintenance

A lightweight tower truck was put into service on the East Bay approaches during the fiscal year to supplement the work of the heavy tower truck. This equipment is used for changing lamps and cleaning luminaires. The new machine is a one-man rig and consists of an extension ladder and rotating base mounted on a one-ton pickup truck. A small gasoline-driven generator and transformer supply the necessary current for lamp testing.

Painting

Structural painting during the past fiscal year has proceeded at a somewhat accelerated pace over the previous year. An average crew of twenty painters (exclusive of foremen and equipment operators) was working during the twelve months compared with an average of twelve painters for the last nine months of the previous period. Additions to the personnel during the year have raised the crew to a present strength of two foremen, thirty-one painters, two equipment operator-laborers and one laborer.

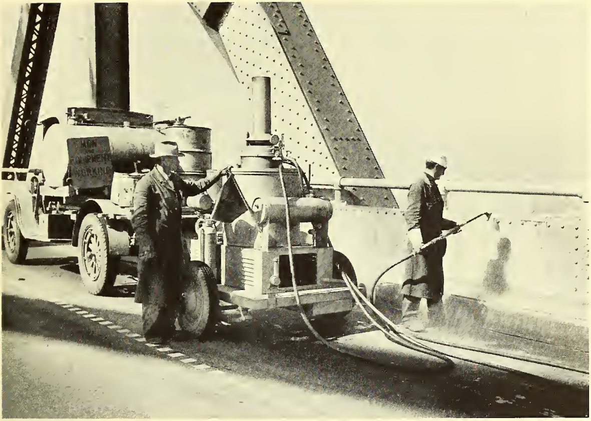
Weather conditions, from a painting viewpoint, improved over the previous year. Possible painting weather, in terms of percentage of available working time, increased from 57.8 per cent to 90.7 per cent for the months of October to June, inclusive, which are comparable in both years. Maintenance painting started October 1, 1937. The corresponding figure for the twelve months of 1938-9 stood at 82.2 per cent.

Increase in Paint Maintenance

This improvement in weather was reflected in increased progress and efficiency in the work. The average amount of paint applied per man per eight-hour day increased from 0.72 gallons in the previous year to 0.99 gallons during 1938-9. Inasmuch as some fifty-five per cent of possible painting time was spent in rigging the staging and surface cleaning (of this percentage approximately forty-five per cent was given to cleaning) this amount represents a good, if not excellent, production per man. Approximately fifteen per cent of the structural painting is done with air brushes, the remainder by hand brushing.

The forty-five per cent ratio allotted to cleaning indicates one point of attack to secure increased painting efficiency. Cleaning to date has largely been done by steel brushing with pneumatic power tools supplemented by occasional hand brushing. For reasons discussed in the Fifth Annual Report, this appeared to be the most acceptable of available methods of cleaning prior to repainting. However, in the particular areas in which maintenance work is now required (between decks and

Dial Control for the Bridge Lighting System



Steam Cleaning, Preparatory to Painting

areas immediately adjacent to roadways), the amount of cleaning necessary is considerably heavier than on other portions of the structure and costs between seven and ten cents per square foot of actual area cleaned. The net figure is difficult to determine due to concurrence of cleaning and painting operations. Other portions of the structure will need less actual cleaning but will require more difficult staging and hence appeared to offer little, if any, promise of reduction in unit cost.

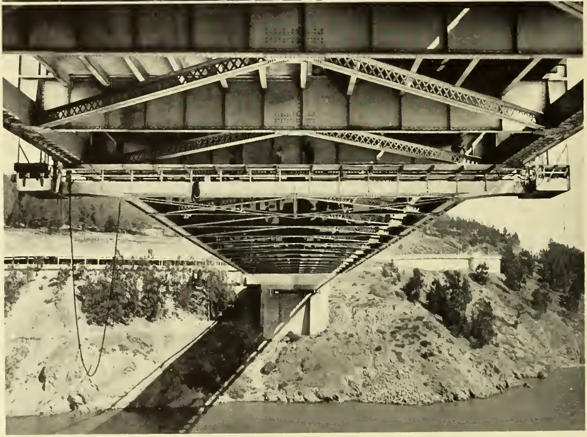
After considerable investigation of ways and means of obtaining more work out of the "cleaning dollar," a portable steam cleaning unit was purchased as an experimental effort. This equipment is similar to the steam cleaning machine used in garages and other industrial plants for cleaning greases, oils, and such matter from car chassis and engines. It is essentially a boiler with a flash type heating coil generating low pressure steam.

Hot water mixed with the steam in the heating coils acquires considerable velocity by virtue of the steam pressure and is directed by means of a hose and proper atomizing nozzle upon the work to be cleaned. Addition of suitable solvents to the water supply expeditiously removes the soil films even though they be thoroughly cemented with oils or grease.

Cleaning Costs Reduced

The cleaner purchased was put in service on the Bridge in mid-June. Initial results have exceeded expectations. Unit cleaning cost on the areas selected for initial trial of the equipment is of the order of one cent per square foot and the quality of the cleaning is definitely superior to that obtained with wire brushing. An excellent feature of the cleaning method is the lack of abrasion and injury to paint film which is in otherwise good condition. While it is not expected that the low unit cost mentioned above can be maintained on the more inaccessible surfaces, still it is apparent that an appreciable reduction of cleaning costs is now in prospect.

Painting Beneath the Lower Deck



Steel Gantry Used for Painting Maintenance Beneath the Bridge Superstructure

Paint formulae and procedure on maintenance remain substantially as in the previous year. Two lead coats applied to failed areas followed by a finish coat of aluminum is used on the major portion of the work. In some few instances, a third lead coat is applied prior to the finish aluminum. Bituminous or graphite paints over lead are used in certain areas. The use of these paints accounted for approximately eleven per cent of the total paint applied during the year. A considerable number of paints advocated for both priming and finish coats were applied on test panels during the year.

Paint Procedure Described

Just prior to the opening of interurban train operations on the Bridge, the California Railroad Commission ordered certain revisions in the paint gantry operating on the lower deck in order to provide increased clearances. These changes were of such a nature as to require the removal of the cantilever arm on the gantry. In operation, this arm swings out over the railroad tracks and catenary to provide access to upper deck floor steel over this area. Due to the difficulty of revising the existing gantry to meet clearance requirements, it was decided to provide two new gantries, one for the East Crossing and one for the West, and retain the present one, minus the arm, as an auxiliary unit to work over the lower deck truck lanes only. These new gantries are now in process of fabrication and will shortly be installed on the Bridge.

Eight pneumatic rotary and angle grinders were purchased during the year. With these items, major equipment on the job includes:

Painting Equipment Listed

(*a*) One eighty-five cubic-foot portable two-stage compressor on two-wheel mounting.

(*b*) Two one-hundred-and-five cubic-foot portable two-stage compressors on two-wheel mounting.

(*c*) Twelve pneumatic angle buffers and eight pneumatic radial buffers.

(*d*) Eight paint spray guns and five ten-gallon spray pots fully equipped.

Expenditures for paint maintenance during the past year amounted to $61,243.19—distributed as follows:

Paint	$9,344.77
Equipment	4,648.31
Payroll	47,250.11

Data on maintenance paint is recorded in Table XII and Table XIII, pages 97 and 98.

Structural Maintenance

Structural maintenance is as yet of a minor nature. The roadside maintenance crew, with the occasional assistance of some of the painting crew, has handled most of the work to date. The replacement of timbers in pier fenders and the erection of stay rods and bracing timbers on the fenders was the main item of structural maintenance during the year. A total of $2365 was spent on this work.

Pier Fenders Replaced

Following the opening of interurban train service on the Bridge January 15, 1939, it was anticipated that some defective rivets would show up, particularly in the railroad stringers and floor beams. Two full-time inspectors were assigned to continuous inspection of the structure. It is expected that these men will be able to make complete inspections of the Bridge annually with more frequent observation of particular points such as the railroad floor system and roadway expansion joints.

Minor repairs will be effected by the inspectors with the assistance of qualified members of the present personnel until such time as experience indicates the need for organizing a special structural repair crew.

It has been necessary to date to replace some fifty rivets, largely in the railroad stringers. This is a negligible percentage of the total. At the present time, rivet replacements are made with high tensile turned bolts, in preference to driving rivets at a high unit cost.

Roadway Maintenance

Bridge Tunnel Washed

A crew of six laborers, one gardener and one leadingman is employed on general roadway and roadside maintenance, all under the general direction of a foreman who likewise directs the activities of the roadside emergency service. Weekly cleaning of the Bridge roadway, quarterly washing of the Yerba Buena Island tunnel lining, maintaining the roadway at the Toll Plaza free from grease and litter are typical routine duties of this crew. Slope and embankment repairs, weed eradication on Bridge properties and roadside, correction of drainage obstructions, crack filling, roadside planting, maintenance at the Toll Plaza and Yerba Buena Island and other numerous and varied activities keep the small force constantly occupied.

A major operation for this crew during the past year was the elevation of the approach pavement to the main Toll Plaza under heavy traffic. Some five hundred tons of plant mix asphalt were placed on this project with a minimum of inconvenience to the traveling public.

TABLE I

OPERATING EXPENSE

JULY 1, 1938, TO JUNE 30, 1939

Administrative expense	$4,245.19
Supervising engineer and staff (maintenance)	14,877.12
Roadway, fire and tow service	37,519.51
Bridge structure, maintenance and repair	4,385.64
Sprinkler system—Pier 24	162.20
Floating equipment and operation	1,854.89
Painting—maintenance and repair	61,360.50
Electrical and signal maintenance and repair	32,579 05
Electric energy (power and light)	18,092.14
Shop, auto repairs and stores	13,552.27
Tools and equipment	295.06
Administration building, additions, maintenance and repair	8,408.04
Clerical and office staff	44,023.70
Office supplies and furniture	2,240.27
Toll collection	130,633.43
Servicing axle counters	3,476.10
Advertising	681.71
Printing	8,655.07
MISCELLANEOUS	
Legal	669.91
Medical	81.54
INSURANCE	
Bridge structure and physical damage	111,600.00
Bonding and burglary	875.65
Compensation	9,862.18
Retirement reserves	3,989.68
	$514,120.85

TABLE II

TABULATION OF DEBT SERVICE

12 months ending March 1	Interest	Serial Maturities Due at End of Period	Minimum Sinking Fund Payments (Including Premium)	Annual Bond Service	Minimum Reserve Fund Payments	Total Annual Bond Service and Minimum Reserve Fund Payments	Amounts Available From Reserve Fund for Retirements of Sinking Fund Bonds	Principal Amount of Outstanding Bonds at End of Period
	(All amounts in thousands of dollars)					*		
1940	$2,840	$260	...	$3,100	$620	$3,720	...	$70,740
1941	2,830	350	...	3,180	636	3,816	515	70,204
1942	2,802	440	...	3,242	649	3,891	649	69,161
1943	2,760	480	$53	3,293	659	3,952	660	68,040
1944	2,715	570	53	3,338	667	4,005	669	66,795
1945	2,665	660	53	3,378	675	4,053	677	65,451
1946	2,611	755	53	3,419	683	4,102	685	63,999
1947	2,553	845	52	3,450	690	4,140	691	62,450
1948	2,491	915	52	3,458	692	4,150	693	60,827
1949	2,426	990	52	3,468	694	4,162	694	59,127
1950	2,358	1,065	52	3,475	695	4,170	696	57,345
1951	2,287	1,145	52	3,484	696	4,180	698	55,481
1952	2,212	1,175	104	3,491	698	4,189	699	53,560
1953	2,135	1,265	103	3,503	701	4,204	702	51,523
1954	2,053	1,355	103	3,511	702	4,213	704	49,387
1955	1,968	1,450	103	3,521	704	4,225	705	47,154
1956	1,876	1,550	103	3,531	706	4,237	706	44,819
1957	1,785	1,655	103	3,543	708	4,251	710	42,378
1958	1,687	1,760	103	3,550	710	4,260	711	39,829
1959	1,585	1,870	102	3,557	712	4,269	712	37,162
1960	1,478	1,985	102	3,565	714	4,279	714	34,379
1961	1,367	2,105	102	3,574	715	4,289	716	31,474
1962	1,251	2,225	102	3,578	715	4,293	717	28,448
1963	1,130	2,350	102	3,582	716	4,298	717	25,296
1964	1,004	2,480	101	3,585	717	4.302	719	22,007
1965	872	...	2,707	3,579	716	4,295	717	19,907
1966	762	...	2,818	3,580	716	4,296	717	16,476
1967	624	...	2,949	3,573	715	4,288	716	12,914
1968	480	...	3,095	3,575	715	4,290	716	9,214
1969	330	...	3,210	3,540	80	3,620	4,082	5,665
1970	113	...	...	113	...	113	...	...

*Includes an additional amount equal to twenty per cent of the minimum scheduled bond retirements and interest due that year, required by bond resolution. This amount is used to retire additional bonds.

TABLE III

FINANCIAL AND REVENUE ACCOUNT

	Fiscal year July 1, 1938, to June 30, 1939		Fiscal year November 12, 1936, to June 30, 1939	
REVENUE				
Traffic tolls	$4,919,443.92		$12,823,926.03	
Train-passenger tolls	240,789.86		240,789.86	
Total toll revenue	$5,160,233.78			$13,064,715.89
Rents from concessions	7,770.31		9,370.31	
Interest on reserve fund investments	8,227.66		16,009.06	
Over and short account	313.10		5,249.64	
	$5,176,544.85			
Commute book suspense	681.00	$5,177,225.85	4,288.00	34,917.01
BALANCES, JUNE 30, 1938				
Funds on hand	$3,864,199.66	3,864,199.66		
		$9,041,425.51		13,099,632.90
DISBURSEMENTS				
Interest paid on outstanding bonds	$2,860,360.32		5,809,804.63	
Accrued interest paid on investment bonds	29,413.38		....	
T.S.R. bonds redeemed	500,000.00		760,000.00	
Premiums paid on treasury bonds purchased	91,126.97		91,126.97	
California Toll Bridge Authority expense	72,598.68		72,598.68	
Fiscal agents expense	386.56		386.56	
Rebate on use and occupancy insurance	—31,050.80		96,949.20	
Counterfeit coins	74.73		251.19	
From construction fund	—9,166.67		740,833.33	
		3,513,743.17		7,571,950.56
FUNDS ON HAND JUNE 30, 1939				
Accounts receivable	86,253.66		86,253.66	
Cashier's revenue fund	29,991.97		29,991.97	
Cashier's change fund	40,000.00	156,245.63	40,000.00	156,245.63
Fiscal agents				
Anglo California National Bank	1,097,446.94		1,097,446.94	
Bank of America	1,146,588.45		1,146,588.45	
Expense fund	127,401.32		127,401.32	
Time deposits	500,000.00	2,871,436.71	500,000.00	2,871,436.71
Investments, 2% treasure bonds	2,500,000.00		2,500,000.00	
		$9,041,425.51		$13,099,632.90

TABLE IV

SAN FRANCISCO-OAKLAND BAY BRIDGE CONSOLIDATED BALANCE SHEET AS OF JUNE 30, 1939

ASSETS

CURRENT ASSETS			
Cash (cashier's account)		$69,991.97	
Construction fund (State Treasurer)		589,513.28	
TOLL REVENUE FUND			
(Fiscal and Sub-fiscal agents)			
Bank of America, N. T. & S. A.		1,146,588.45	
Anglo California National Bank		1,097,446.94	
Anglo California National Bank (time deposit)		250,000.00	
Bank of America, N. T. & S. A. (time deposit)		250,000.00	
Anglo California expense reserve		127,401.32	
INVESTMENT 2% BONDS			
Par value		2,500,000.00	
Premiums paid		91,126.97	
			2,591,126.97
Accounts receivable (current tolls)		44,814.55	
ACCRUED INCOME			
Accounts receivable (passenger tolls)		41,439.11	
Accrued interest on time deposits		1,219.18	
Accrued interest on treasury bonds		2,055.50	
			$6,211,597.27
FIXED ASSETS			
Direct Construction Cost			
(Investment in bridge) Vehicular		49,078,883.60	
(Investment in bridge) Interurban Transportation System		18,195,884.01	
Interest during construction	$5,133,926.92		
Less interest rebate from R. F. C.	1,215,583.75		
		3,918,343.17	
Discount on bonds		2,235,602.94	
			73,428,713.72
DEFERRED CHARGES			
Prepaid use and occupancy insurance			42,011.32
Total assets			$79,682,322.31

LIABILITIES AND EXCESS

FIXED LIABILITIES		
Bonded debt		
Serial revenue bonds, 4%	$31,700,000.00	
Series sinking fund revenue bonds, 4%	39,300,000.00	
		$71,000,000.00
DEFERRED LIABILITIES		
Commute book suspense	$4,288.00	
Accrued interest on $71,000,000.00 bonds—March 1, 1939, to June 30	946,666.67	
Contract obligations	589,513.28	
		1,540,467.95
Excess of assets over liabilities		7,141,854.36
Liabilities and excess		$79,682,322.31

Note: Excess of assets over liabilities is fund available for interest and redemption of outstanding bonds and is the difference between toll receipts and expenditures made for interest, redemption and other bond expense.

No provision has been made for depreciation and amortization of bridge facilities. This will be done when construction costs are completed.

TABLE V

TOLL SCHEDULE

Class	Vehicles	Rate
1	Automobiles, ambulances, taxis, commercial or light delivery automobiles, all with driver and not to exceed four (4) additional passengers	$0.50[1]
	Passengers in excess of four (4) . . . each	.05
2	Trailers drawn by automobiles	.50
	Passengers riding trailer . . . each	.05
3	Trucks (with driver)	.60
	Passengers in excess of driver . . . each	.05
4	Truck trailer	.60
	Passengers riding trailer . . . each	.05
5	Buses with driver	.75[4]
	Passengers in excess of driver . . . each	.05[4]
6	Motorcycle with driver	.20
	Additional passengers . . . each	05
7	Tricar with driver	30
	Additional passengers . . . each	.05
8	Vehicles not otherwise specified and/or vehicles requiring a special permit to travel on bridge . . . per 100 lbs.	.02
9	Road construction equipment (with driver)	.60
	Passengers in excess of driver . . . each	.05
10	Load carried on any truck or truck trailer . . . per 100 lbs.	.02
11	Commute—Passenger automobiles only, with driver and not to exceed four (4) passengers, two (2) one-way trips, undated tickets, for every day of the calendar month except Sundays. (Tickets will be honored on Sundays.) Minimum fifty (50) one-way tickets; maximum, fifty-four (54) one-way tickets	17.50[2]
	Passengers in excess of four (4) . . . each	.05
12	Commute—Passenger automobiles only, with driver and not to exceed four (4) passengers, forty (40) one-way trips, undated tickets in any calendar month. (Tickets will be honored on Sundays)	14.50[3]
	Passengers in excess of four (4) . . . each	.05
13	All classifications to Treasure Island 50% of the above charges	50%

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[1] Reduced to $0.40, effective June 24, 1939.
[2] Reduced to $14.00, effective July 1, 1939.
[3] Reduced to $11.60, effective July 1, 1939.
[4] Effective January 15, 1939, Key System buses, operating on regular schedules between San Francisco and certain East Bay areas, charged 2½c per passenger carried only.

TABLE VI

CLASSIFICATION OF VEHICLES

Period	Automobiles, Automobile Trailers and Light Commercial Vehicles		Buses	Trucks and Truck Trailers	Motorcycles and Tri-cars	Total Toll Vehicles	Free [7] Vehicles	Total [6] Vehicles	Extra [6] Passengers	Freight [6] (in tons)	Treasure Island Traffic	
	Cash Toll	Commuters									Vehicles	Freight (in tons)
November 12, 1936 to June 30, 1937	[1]5,185,116	[1]359,984	42,753	176,264	22,878	5,786,995	50,840	5,837,835	1,080,214	176,501	....	....
July 1, 1937 to June 30, 1938	7,160,979	869,194	124,380	[2]342,320	41,806	8,538,679	116,303	8,654,982	2,227,803	411,499	51,755	11,832
July, 1938	601,430	68,008	13,467	35,952	4,035	722,892	14,486	737,378	241,163	43,750	10,461	3,361
August	621,376	73,768	13,432	41,631	4,161	754,368	15,716	770,084	244,728	55,518	14,831	8,939
September	585,545	73,539	13,153	39,321	3,809	715,367	15,462	730,829	233,561	53,943	19,049	11,104
October	605,515	83,866	13,594	41,037	3,660	747,672	15,311	762,983	235,728	54,342	32,369	9,524
November	625,139	84,307	13,239	41,503	3,671	767,859	15,393	783,252	237,999	57,961	40,357	13,421
December	623,823	86,083	13,616	41,871	2,879	768,272	15,574	783,846	247,439	57,450	46,121	15,767
January, 1939	586,758	80,890	13,105	43,651	2,774	727,178	18,917	746,095	224,226	62,421	58,532	19,038
February	600,288	72,846	12,445	46,832	2,869	735,280	18,407	753,687	215,228	67,245	[5]146,317	28,344
March	653,459	85,354	15,705	47,138	3,037	804,693	18,221	822,914	259,266	59,981	164,642	11,419
April	689,417	77,910	16,407	44,790	3,467	831,991	17,326	849,317	296,604	54,830	169,806	7,468
May	681,854	79,796	17,350	47,352	3,759	830,111	17,814	847,925	317,137	59,345	153,424	8,661
June [4]	[4]727,793	76,053	16,169	47,735	3,995	871,745	16,650	888,395	302,140	61,998	157,385	7,741
Totals, July 1, 1938 to June 30, 1939	7,602,397	942,420	171,682	518,813	42,116	9,277,428	199,277	9,476,705	3,055,219	688,784	1,013,294	144,787
Totals Since Opening of Bridge	19,948,492	2,171,598	338,815	1,037,397	106,800	23,603,102	366,420	23,969,522	6,363,236	1,276,784	1,065,049	156,619

[1] Automobile toll reduced from $0.65 to $0.50, February 1, 1937. Commute rate reduced from $22.50 to $17.50.

[2] Truck toll reduced from $0.75 to $0.60 and freight charge from $0.03 to $0.02 per cwt., May 1, 1938.

[3] Toll on regular Key Buses reduced from $0.75 for bus and $0.05 per passenger to $0.02½ per passenger, January 15, 1939.

[4] Automobile toll reduced from $0.50 to $0.40, June 24, 1939.

[5] Exposition opened to the public February 18, 1939.

[6] Includes Treasure Island Traffic.

[7] Free vehicles include:
a. United States Government vehicles on official business.
b. Bridge maintenance vehicles.

TABLE VII—TRAFFIC AND REVENUE RECORD

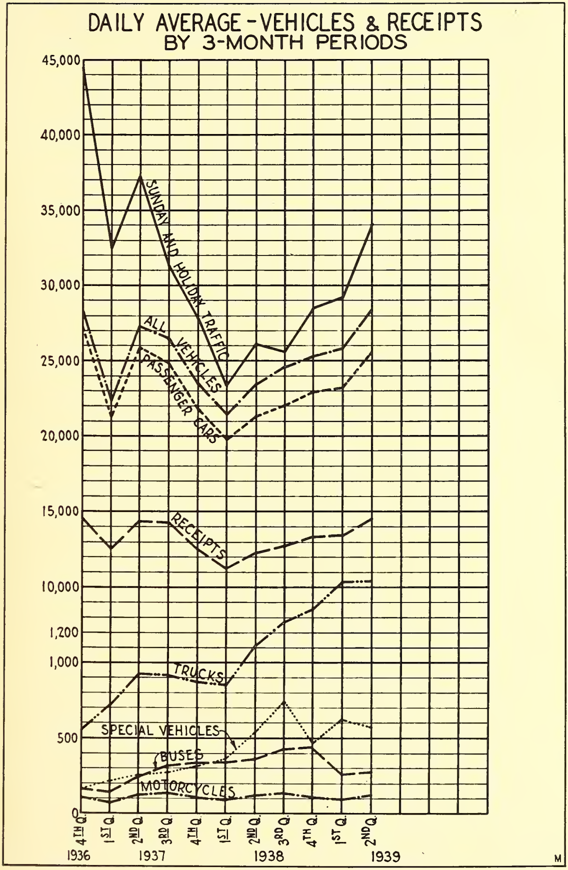
Period	Vehicular Traffic			Interurban Traffic					Rents	Interest Earned Bank Deposits	Interest Earned Securities Held	Over and Short Account	Total Revenue
	Vehicles	Average Toll per Vehicle	Revenue	Passengers				Total Revenue					
				Interurban Electric	Key [6] System	Sacramento Northern	Total [5]						
Nov. 12, 1936 to June 30, 1937	[1]5,837,835	.570	$3,329,131							$4,023		$4,696	$3,337,850
July 1, 1937, to June 30, 1938	[2]8,654,982	.528	$4,575,351						$1,600	3,758		$240	$4,580,949
July, 1938	737,378	.525	$386,723						$100			$12	$386,835
August	770,084	.526	405,066						100			17	405,183
September	730,829	.526	384,423						100			72	384,595
October	762,983	.524	399,820						100			10	399,930
November	783,252	.524	410,710						100				410,810
December	783,846	.523	410,227						100			25	410,352
January, 1939	[3]746,095	.519	387,510	540,555	556,976	8,430	1,105,961	$27,649	125			134	415,418
February	753,687	.519	390,807	794,468	837,620	13,851	1,645,939	41,131	150				432,088
March	822,914	.514	422,904	887,465	899,903	14,180	1,801,548	44,945	162				468,011
April	849,317	.517	439,521	832,214	865,317	16,132	1,713,663	42,804	1,093			11	483,429
May	847,925	.519	439,738	838,963	858,553	16,777	1,714,293	42,822	3,015			32	485,607
June [4]	888,395	.498	441,992	814,315	828,443	15,562	1,658,320	41,439	2,625		$8,227		494,283
Totals, July 1, 1938 to June 30, 1939	9,476,705	.519	$4,919,441	4,707,980	4,846,812	84,932	9,639,724	$240,790	$7,770		$8,227	$313	$5,176,541
Totals Since Opening of Bridge	23,969,522	.535	$12,823,923	4,707,980	4,846,812	84,932	9,639,724	$240,790	$9,370	$7,781	$8,227	$5,249	$13,095,340

[1] Automobile toll reduced from $0.65 to $0.50 February 1, 1937. Commute rate reduced from $22.50 to $17.50.
[2] Truck toll reduced from $0.75 to $0.60 and freight charge from $0.03 to $0.02 per cwt., May 1, 1938.
[3] Toll on regular Key buses reduced from $0.75 for bus and $0.05 per passenger to $0.02½ per passenger, January 15, 1939.
[4] Automobile cash toll reduced from $0.50 to $0.40, June 24, 1939.
[5] Passenger record includes 8,131 United States Government employees on official business carried toll free by Key System.

TABLE VIII—COMPARISON OF BRIDGE AND FERRY TRAFFIC BETWEEN SAN FRANCISCO AND EAST BAY CITIES

Period	Vehicles							Freight (in tons)				
	Ferry			Bridge [4]	Total Traffic	Per cent by Ferry	Per cent by Bridge	By Ferry [3]	By Bridge [4]	Total	Per cent by Ferry	Per cent by Bridge
	Oakland Pier	Alameda	Total									
November 12, 1936 to June 30, 1937	176,338	8,579	[1]184,917	5,821,177	6,006,094	3.08	96.92	202,586	176,501	379,087	53.44	46.50
July 1, 1937 to June 30, 1938 [5]	2,852,748	88,696	[2]2,941,444	8,619,885	11,561,329	25.45	74.55	258,796	399,667	658,463	39.33	60.67
July, 1938	293,587	10,090	303,677	726,917	1,030,594	29.47	70.53	20,057	40,389	60,446	33.18	66.82
August	295,308	10,059	305,367	755,253	1,060,620	28.78	71.21	22,593	46,579	69,172	32.66	67.34
September	276,002	8,348	284,350	711,780	996,130	28.55	71.45	20,909	42,339	63,248	33.06	66.94
October	277,930	8,534	286,464	730,614	1,017,078	28.17	71.83	21,393	44,814	66,207	32.31	67.69
November	268,256	9,064	277,320	742,895	1,020,215	27.18	72.82	19,908	44,540	64,448	30.89	69.11
December	255,730	8,176	263,906	737,725	1,001,631	26.35	73.65	17,587	41,683	59,270	29.67	70.33
January, 1939	246,612	4,221	250,833	687,563	938,396	26.73	73.27	17,558	43,383	60,941	28.81	71.19
February	219,321	614	219,935	607,370	827,305	26.58	73.42	15,718	38,901	54,619	28.78	71.22
March	244,207	12	244,219	658,272	902,491	27.06	72.94	19,744	48,562	68,306	28.91	71.09
April	260,881	6	260,887	679,511	940,398	27.74	72.26	17,614	47,362	64,976	27.11	72.89
May	276,222	8	276,230	694,501	970,731	28.47	71.53	19,312	50,683	69,995	27.59	72.41
June	264,124	4	264,128	731,010	995,138	26.54	73.46	21,864	53,758	75,622	28.91	71.09
Totals, July 1, 1938 to June 30, 1939	3,178,180	59,136	3,237,316	8,463,411	11,700,727	27.66	72.34	234,257	542,993	770,250	30.14	69.86
Totals, Since Opening of Bridge	6,207,266	156,411	6,363,677	22,904,473	29,268,150	21.75	78.25	695,639	1,119,161	1,814,800	38.33	61.67

[1] Does not include 119,118 via Berkeley Pier route and 1,120 via the Broadway Ferry.
[2] Does not include 6,074 via Berkeley Pier route and 378 via the Broadway Ferry both of which were discontinued August 15, 1937.
[3] Includes Oakland Pier and Berkeley routes only.
[4] Treasure Island traffic not included.
[5] Ferry tolls reduced to approximately 58% of bridge tolls on August 11, 1937.



DAILY AVERAGE - VEHICLES & RECEIPTS
BY 3-MONTH PERIODS

TABLE X

ROADSIDE SERVICE AND ACCIDENTS SAN FRANCISCO-OAKLAND BAY BRIDGE

JULY 1, 1938, TO JUNE 30, 1939

Roadside Service, Bridge and Approaches	July 1, 1938, to June 30, 1939	Total Since Opening of Bridge
Vehicles supplied with gasoline, oil and miscellaneous services	3,412	9,658
Vehicles towed (engine trouble, no spare tires, accidents, etc.)	1,806	5,234
Tires changed	1,051	2,743
Fires	38	89[1]
Total vehicles service	6,287	17,704[1]
Average number of vehicles serviced per day	17.22	18.42
Number of vehicles crossing bridge per vehicle serviced	1,507	1,354

Accidents on Bridge	July 1, 1938, to June 30, 1939	Total since opening of bridge
Total accidents	57	149
Involving personal injury	24	67
Persons injured	55	150
Fatal accidents	3	7
Property damage only	30	75

[1] Six false alarms previously reported as fires are not included in these figures.

TABLE XI

SODIUM VAPOR LAMP OPERATION

JULY 1, 1938, TO JUNE 30, 1939

Fiscal Year 1938-1939

Total number of luminaires, bridge and approaches	1,081
Total number of burned-out lamps replaced	1,494
Average burning hours for system except tunnel, lower deck	3,438
Average burning hours for tunnel, lower deck	8,760
Average burning hours per lamp of burn-outs	2,296
Per cent lamps replaced to total luminaires	138%

SEGREGATION—LAMP REPLACEMENTS

	Total Luminaires	Replacements	Per cent Replacements	Average Burning Hours per Lamp
San Francisco approaches	108	135	125	2,342
Suspension bridges	244	342	140	2,221
Tunnel, lower deck (circuits 9 and 10)	17	26	153	5,808
Tunnel, upper deck	14	19	136	2,639
East portal of tunnel to E-28	226	301	133	2,276
East Bay approaches, distribution structure, and East Shore Highway	472	671	142	2,187

TABLE XII

MAINTENANCE PAINTING RECORD

Period	Labor (in Man-hours)									Paint (in Gallons)					
	Average Crew	Painting (Includes Cleaning)				Maintenance Cleaning	Miscellaneous Work	Lost Time	Total Man-hours	Bridge Paint				Miscellaneous Paint	Total Paint
		First Coat	Second Coat	Third Coat	Fourth Coat					Lead	Aluminum	Bituminous	Graphite		
October 1, 1937-June 30, 1938	12	8,066	1,844	630	730	1,706	4,153	1,487	18,616	798	150	158	0	118	1,224
July	14	1,342	459	0	280	0	119	0	2,200	88	30	8	0	7	133
August	17	1,256	390	0	1,138	0	112	0	2,896	106	224	5	32	13	380
September	20	1,433	187	59	994	19	475	0	3,167	74	24	23	13	30	164
October	20	995	1,307	4	355	0	283	0	2,944	224	83	31	19	18	375
November	20	660	672	0	848	39	655	18	2,892	118	130	5	9	15	277
December	20	466	876	40	163	39	1,021	492	3,097	169	53	15	2	10	249
January	19	1,128	380	4	628	177	669	98	3,084	90	232	42	3	10	377
February	20	735	652	0	396	16	769	144	2,712	101	122	27	9	18	277
March	20	1,334	758	112	358	0	499	224	3,285	129	106	1	0	2	238
April	20	1,398	534	32	562	0	398	0	2,924	134	195	16	6	2	353
May	20	1,417	457	0	664	0	562	0	3,100	119	201	17	12	15	364
June	25	2,227	594	0	698	0	725	0	4,244	262	207	68	80	18	635
Totals		22,457	9,110	881	7,814	1,996	10,440	2,463	55,161	2,412	1,757	416	185	276	5,046
Total July 1, 1938, to June 30, 1939		14,391	7,266	251	7,084	290	6,287	976	36,545	1,614	1,607	258	185	158	3,822
Percentage		39.3	19.9	0.7	19.4	0.8	17.2	2.7	100	42.3	42.0	6.8	4.8	4.1	100

TABLE XIII

MAINTENANCE PAINTING—SUMMARY OF DELAYS DUE TO WEATHER—TIME IN HOURS

JULY 1, 1938, TO JUNE 30, 1939

Month	Working Days	Possible Painting Time (Hours)[1]	Cleaning Only Possible (Hours)	Lost Time (Hours)	Total Hours
July	20	116	44	0	160
August	22	176	0	0	176
September	20	134	26	0	160
October	20	158½	1½	0	160
November	19	135	14	3	152
December	21	102	36	30	168
January	22	102	66	8	176
February	18	88	48	8	144
March	23	156	118	10	184
April	20	132	28	0	160
May	22	172	4	0	176
June	22	166½	9½	0	176
Totals	249	1,638	295	59	1,992
Percentage		82.2	14.8	3.0	100

[1] Bridge painting only.
These figures based on five eight-hour working days per week, excepting holidays.

APPENDIX

Insurance

The original agreement between the California Toll Bridge Authority and the Reconstruction Finance Corporation provided ". . . that so long as any of the bonds are outstanding the Bridge and structures on approaches shall at all times, both during and after construction, be insured against all risks to the full insurable value thereof.

Proceeds of Insurance

"The cost of such insurance shall be paid by the State of California by means other than the revenues of the Bridge and the proceeds of such insurance shall be applied to the restoration of the Bridge and structures on approaches to at least the same good order, repair, and condition as it was prior to the damage in so far as same may be restored from the said proceeds.

"There shall also be carried use and occupancy insurance in an amount to be determined from time to time equal to two years' current estimated gross revenues of the Bridge. The cost of such use and occupancy insurance shall be paid by the Bridge Authority out of the revenues of the Bridge. The proceeds of such use and occupancy insurance shall be paid to the Bridge Authority and by it paid into the revenue fund and shall be paid out to the same purpose and in the same manner as other moneys in the said fund."

Under the California statutes of 1933 relating to the Division of Highways, the State Department of Public Works was directed to carry insurance during construction of the San Francisco-Oakland Bay Bridge and its approaches. It was also directed, after completion of the project, "to make expenditures . . . for the cost of insurance" against all risks to the full insurable value and against loss of use and occupancy.

Construction Insurance

As provided by law and in accordance with its agreement with the Reconstruction Finance Corporation, the California Toll Bridge Authority acquired multi-risk insurance to the amount of $33,000,000 during the construction period. The premium was paid from construction funds.

This policy expired September 1, 1936, and was renewed for $36,000,000 for a five-year period. The insurance covers the construction cost of the main structure and that of its approaches and is not based upon the entire cost of the project, which includes acquisition of right of way, fills, grading, construction interest, and construction overhead. In addition, the Department of Public Works acquired insurance against the loss of use and occupancy to the amount of $8,000,000.

Multi-risk Insurance

The multi-risk insurance provides coverage against direct loss by damage resulting from fire, lightning, floods, rising waters, ice, collision, allision, explosion, strikes, riots, civil commotions, sabotage, malicious damage, tornado, wind storm, earthquake and collapse, and subsidence resulting in failure of the Bridge or any part thereof.

The cost of the multi-risk insurance on a five-year basis averages thirty-two cents per one hundred dollars per annum. The premiums, totaling $576,000, were paid by the Department of Public Works to September 1, 1941, from the Bridge's maintenance and operation fund derived from gas tax resources.

The original insurance contract provided for use and occupancy insurance to the amount of $8,000,000 as stated above, covering loss of tolls through damage to the Bridge for a period of 737 days.

This time clause was revised by amendment of the Bond Resolution approved by the Authority November 29, 1938, and placed in effect in December, 1938, in connection with the revision of a number of other concentrated value risks in the United States.

Use and Occupancy Insurance

The revised use and occupancy policy now provides for insurance for a loss of use and occupancy until the Bridge is completely restored to service for each day of the total or partial suspension of use in excess of seven and not to exceed 372 days. The amount of the insurance is $4,250,000. The premium, totaling $68,000, was paid from Bridge revenues by the Fiscal Agent. The rate is thirty-two cents per annum per one hundred dollars.

Insurance for Bridge Railway

While the multi-risk insurance covers the Bridge Railway facilities on the structure, it does not include insurance of the San Francisco Terminal and railway approaches and viaducts; nor the cars leased by the Authority to the Carriers; nor public liability and property damage. Insurance for these items is being carried by the interurban companies, in accordance with the Railroad agreements, in total amount of $8,300,000.

Both multi-risk and use and occupancy policies are on a five-year basis, expiring September 1, 1941, and are cancellable by the insurers on sixty days' notice.

View of the Bridge and San Francisco Railway Facilities

Geological Report on Foundation Conditions

⟦From Reports of the Consulting Geologists⟧

The quality and condition of foundation materials upon which Bridge piers rest were objects of an intensive investigation. Bridge foundations are required to support not only normal loads but must be able to resist vertical stresses arising from wind, earthquake, and other contingencies of from two to four times the normal load.

West Crossing

Depth of water along the West Crossing, from the San Francisco shoreline to Yerba Buena Island, ranges from twenty-nine feet to one hundred and thirteen feet. Bedrock was found to lie at depths varying from seventy-eight feet to two hundred and twenty-five feet below the water surface.

Bedrock Depths

Drilling operations at each of the six pier sites of the West Crossing revealed that bedrock is comprised of a hard sandstone of Franciscan formation, associated locally with equally strong greenstone.

San Francisco Anchorage

The San Francisco Anchorage, a gravity block of concrete, rests upon bedrock consisting of hard sandstone, chert, shale, limestone and greenstone of great strength. Geologically of high quality, the foundation material is more than capable of bearing the anchorage's average load of 6.3 tons per square foot and the calculated maximum load of 10.4 tons per square foot.

Pier W-1

Approximately fifty-five feet of artificial fill, blue mud, sand and clay overlies the bedrock at Pier W-1, located on the shore just west of the Embarcadero. Excavation was carried well into the strong sandstone bedrock.

Pier W-2

Depth of water at the site of Pier W-2, just off shore, ranges from twenty-nine to sixty-two feet, with bedrock at depths of seventy-eight to ninety-eight. Test borings showed a bedrock of hard gray sandstone, capable of bearing a load far greater than the calculated maximum of 21.5 tons per square foot.

Pier W-3

Bedrock at Pier W-3 lies two hundred and eighteen feet below the surface of the water, which at this site is seventy-one feet deep. Test borings here revealed the presence at bedrock of hard gray sandstone and some black shale, having bearing-strength values far above the average calculated load of 10.3 tons per square foot and maximum load of forty-one tons.

Pier W-4

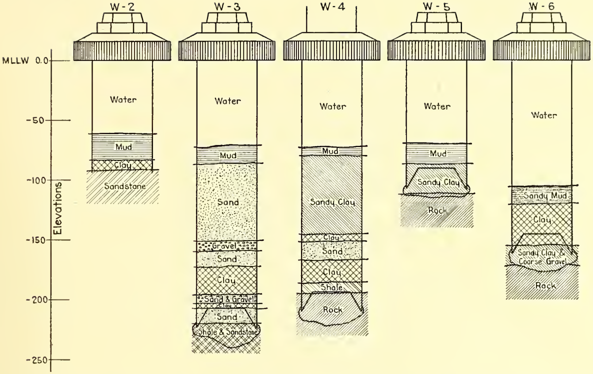
Test borings at Pier W-4, which penetrated the rock to depths of from thirty to one hundred and five feet, indicated that the bedrock at this point consists of a hard and strong black shale, more than capable of bearing the average load of 12.2 tons per square foot and the maximum calculated load of 51.3 tons imposed here. Water is approximately seventy-one feet deep at this pier and bedrock is two hundred feet below the surface.

Pier W-5

A bedrock of greenstone, sandstone and some shale, of a hard strong consistency, was shown in test borings at Pier W-5, which penetrated as far as ninety-seven feet into the rock. Bedrock here is from one hundred and five to one hundred and seven feet below the water surface, which is approximately seventy feet deep. Foundation materials are well able to bear the average load of 10.5 tons per square foot and the maximum load of twenty-one tons per square foot.

Pier W-6

Water depths at Pier W-6 are approximately one hundred and five feet and bedrock is one hundred and seventy-five feet below the surface of the Bay. Test



Geological Foundations, West Crossing

borings were made to a depth of one hundred and three feet into bedrock and revealed that the formation at this site is comprised of chert, black shale, sandstone and greenstone, all strong materials. The average load on this pier is estimated at 9.75 tons per square foot and the maximum load at 27.2 tons.

Yerba Buena Island Anchorage

The cable anchorages penetrate a rock strata consisting of strong and fresh Franciscan sandstone. The strata here dip at moderate angles to the northeast and away from the Bridge, a very favorable structural condition. The very high strength of the rock at this point assures the extreme stability of the anchorage.

Yerba Buena Island Tunnel

Yerba Buena Tunnel passes through strong sandstone strata dipping at moderate angles in a northeasterly direction. The rock is stable.

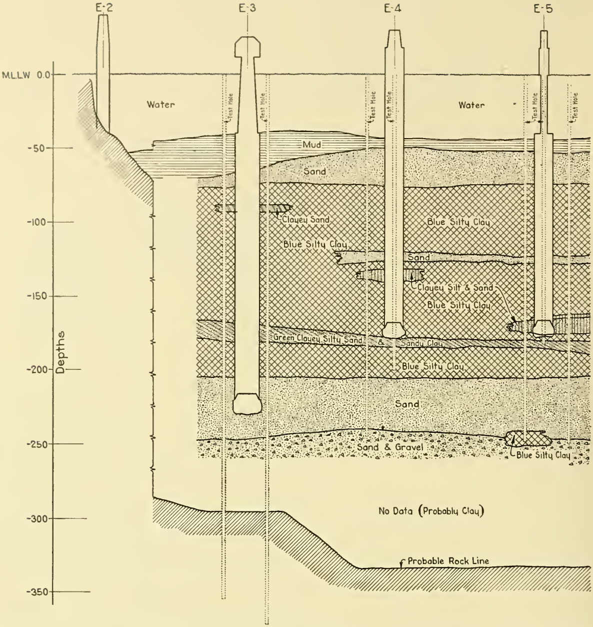
East Crossing

The depth of bedrock surface east of Yerba Buena Island was made known by six borings. Four of these, close to the northeast end of the Island revealed that the bedrock surface at this point is at slight depth, and is composed of sandstone with some layers of shale.

The slope of the surface is very steep, but the rock formation makes an excellent foundation. The bottom deposits on the area enclosed by the four borings are chiefly sand and gravel with strata of underlying clay.

A test boring taken thirteen hundred feet east of the Island showed the depth to bedrock to be 308.1 feet.

This indicated that the rock surface east of Yerba Buena Island is deeper than that between San Francisco and the Island, and that the deepest part of the rock surface is probably still further east.



Geological Foundations East Crossing

Rock Surface at Great Depth

Tests showed that the surface of the bedrock was too deep to be considered as a possible foundation for the piers of the East Crossing. Samples of bottom deposits revealed that below the mud there is an alternation of clays, sandy clays and sands to a depth of about –120 feet with a peaty layer at about –80 feet.

Below this strata there was a persistent layer of sand or very sandy clays about thirty feet thick, which in turn lay on sandy clays, clays and sands which are stiffer and much more unyielding than those above the thirty-foot layer.

It was determined that this sandy layer could safely support the piers of the East Crossing, east of Pier E-3.

Pier E-3

Pier E-3, major sub-aqueous pier of the East Crossing, rests upon deeper, still more sandy gravelly material. This lower sand formation, interstratified with a few beds of sandy clay and containing much gravel in its lower part, extends to a depth of –307.1 feet with its top at about –220 feet.

Pier E-3 goes to a depth of approximately two hundred and forty feet below water, of which about one hundred and eighty feet penetrate mud, clay and sand strata. The average bearing pressure on this pier is seven tons per square foot and the calculated maximum is twenty-six tons per square foot.

Triangulation and Surveys

The surveys required to locate the San Francisco-Oakland Bay Bridge, preliminary to and during construction, involved a great many methods. Some of these had precedent, but others were new, for unusual problems were frequently encountered in gathering data for design of the structure and furnishing lines and grades for the extensive and varied construction operations.

Because of the magnitude and complexity of the surveys required, and the necessity for speedy and accurate results, a department of Triangulation and Surveys was formed for the Bridge project.

Preliminary surveys were undertaken as early as 1931, but actual operations started in January 1933, when the department was formed.

Triangulation

The triangulation system developed for the construction of the Bridge required the most extensive net of any used for a major bridge project. It involved the location of twenty-five deep water piers over more than four miles of water surface.

The triangulation layout was governed by topography among other factors. The time allowed for establishing the system was limited by the construction program and the high degree of accuracy required was dictated by the design of the structure and the specified tolerance in fabricating the steel.

Since surveys to locate structures similar to the San Francisco-Oakland Bay Bridge had not been made in the past, data and precedents were not available. Therefore a careful study had to be made of each problem. Nothing was taken for granted in the determination of the proper limits of rejection and the number of observations required.

Triangulation Net Angles

The angles of the triangulation net were measured at night when the atmosphere was more uniform, freer from smoke, and heat waves were less noticeable. It was also possible to obtain greater accuracy by defining points with artificial light.

The net was adjusted by the method of least squares, for this method gave the most probable values of the angles and furnished a direct solution for a figure in which there are two or more base lines.

Accuracy for Bridge Net

The accuracy of the triangulation net for the Bridge exceeded the requirement for first order triangulation as required by the United States Coast and Geodetic Survey.

As a check against discrepancies which might have occurred in measuring the various sections along the Embarcadero, monuments were placed at convenient intervals along the baseline. The measurement of the base was made with a fifty-meter invar tape supported at predetermined elevations at each end and in the center. The three invar tapes used on the project were standardized at the Bureau of Standards in Washington, D. C. Laboratory conditions were reproduced as closely as practicable when field measurements were made. Tension was applied by the use of weights rather than spring balances. Special marking tables mounted on short, heavy tripods were used as end supports for the tape.

Special Marking Tables Used

The tables were provided with adjusting screws. By means of these screws and the aid of a magnifying glass the hair mark on the table was made to coincide

Left to Right: North Triangulation Station, East Bay, Yerba Buena Island; Rincon Hill Triangulation Station, San Francisco

Left to Right: Army Point Triangulation Station; Triangulation Station, Southern Pacific Fill; Portable Radio Set

Left to Right: Theodolite at Telegraph Hill Station; Telegraph Hill Station

with the end graduations on the tape. The support near the center of the tape was a lightweight composition pulley which moved freely on a ball-bearing support. Points on the monuments were transferred to or from the marking tables by transit.

The check base lines on Yerba Buena Island were broken lines run over irregular ground. They were difficult to measure but gave results, checking closely the calculated lengths as triangulated from the Embarcadero and Key Route base lines.

The Key Route base line was conveniently located along the fill made for the Key Route interurban. It was measured in the same way and with the same precision as the Embarcadero base line.

After the field notes were reduced in the office for corrections of temperature and difference in elevation of supports, they were reduced to mean sea level lengths. The results indicated a probable error of less than one part in one million.

The principal criterion in triangulation is that the discrepancy between the measured length of a base line and its length as computed through the scheme from the next preceding base shall not be greater than one part in 25,000 of the length of the base for first order work. The accuracy for the Bridge net was one foot in 76,500.

This accuracy was attested when the distance between the San Francisco Anchorage and Pier W-4 was subsequently checked by tape measurement along the north cable of the suspension span to a differential of 0.04 feet. Measurements made along the completed East Crossing spans showed that the distances between piers were in all cases within 0.02 feet of the theoretical length and that the greatest accumulated discrepancy between the triangulated and the chained distances amounted to 0.037 feet in a distance of 6,173 feet.

Base Lines

The accuracy with which points may be located by triangulation can only approach the accuracy obtained in measuring a base line. Four base lines were used in the Bridge system to guard against errors. The two major base lines were along the Embarcadero in San Francisco and the Key Route fill in Oakland. Two secondary or check base lines were established on Yerba Buena Island.

The Embarcadero, on which the San Francisco base line was established, is on filled material and is not stable. The line extends from the foot of Telegraph Hill in a straight line to Harbor Pier 24, and thence on a straight line to Harbor Pier 32. The total length of this line was 7517 feet. The rapidly moving and congested traffic along the San Francisco waterfront required that all measurements be made at night.

Triangulation Stations

Ten primary stations were established as the triangulation control for Bridge construction. Two stations were located in San Francisco, one on Telegraph Hill and another on Rincon Hill near the Bridge approach. Three stations were erected on Yerba Buena Island, one on the northwest side controlling West Bay construction; one on the northeast side for East Bay construction and one on the south side overlooking both east and west crossings.

There were three land stations on the Oakland side and two stations erected in the water. The latter were placed approximately 3600 feet apart and 3000 feet north of the Bridge centerline.

Shelter Houses Provided

The observer's platform and instruments at each station were protected from the warping effect of the sun's rays and the vibrations from the wind by shelter houses seven feet square. These were provided with either movable or adjustable windows.

Engineers on the triangulation project were required to learn the International Code for the purpose of sending and receiving messages by semaphore and flashlight in the earlier stages of operation. After the primary-control triangulation net had been established, the land triangulation stations and the construction office at 500 Sansome Street in San Francisco were interconnected by magneto telephones.

Short Wave Radio Sets for Stations

All triangulation stations were, in addition, equipped for short-wave radio sets. The sets were portable and were moved from station to station with the theodolites. Radios were also installed on all boats and at major points of construction.

It was thus possible for field forces to be in constant communication with the construction office and with operations far out on the water through radio. It greatly increased the efficiency and rapidity of the work.

Equipment

Instruments used in measuring the angles of the triangulation net were repeating ten-second theodolites.

The lighting system employed to illuminate the instruments for night work was especially designed. Miniature electric lights illuminated the verniers, and light projected through a hole drilled in the horizontal axis was reflected by a small mirror onto the cross hairs. Batteries with rheostats and switches for the control of cross hairs and vernier illumination were mounted on the instruments.

Experiments made with flashlight lamps, neon tubes and Fresnel lenses to determine the best sights for night work showed that the first gave the best definition for distances as great as four miles.

Rod for Distance Alignments

Range poles were centered on the top of each triangulation station, and used on daylight location for establishing mooring anchors, construction docks, submarine cables and caissons. A special rod was used for alignment at distances of more than a mile. The lining rod or range pole had a diameter of seven inches, and was probably the largest ever used.

Transbay Levels

Levels Projected Four Miles

Construction of the San Francisco-Oakland Bay Bridge was begun simultaneously in San Francisco, on Yerba Buena Island, in Oakland and in the Bay. A common datum was necessary so that these sections might accurately unite to form the completed structure. In order to transfer this datum to the various points of construction, levels were projected as much as four miles by a method known as transbay levels, a development of the river crossing method used by the United States Coast and Geodetic Survey.

Precise levels were used in transbay observations, and work was carried on at night. Results of preliminary observations, made with the use of neon tubes for targets, were sometimes erratic, and further experiments proved that the best targets for transbay leveling consisted of two flashlight globes, one above the other.

Common datum was transferred to the Bridge approach in Oakland by projecting transbay levels from Telegraph Hill in San Francisco to a point near the triangulation station on the west end of Yerba Buena Island, a sight distance of 9,660 feet; and from the triangulation station at the east end of Yerba Buena Island to the roof of the Albers Mill building, adjacent to the Southern Pacific Mole in Oakland, a sight distance of 10,290 feet. These projections were respectively one hundred feet and one hundred and forty feet above the surface of the Bay.

Settlement Records Obtained

Transbay levels were used in establishing elevations on the West Crossing piers and on Pier E-3 of the East Crossing to obtain elevations for settlement records after completion. Settlement records of the West Crossing piers were obtained from the results of transbay levels run between Yerba Buena Island and San Francisco over the completed piers.

The accuracy of transbay levels was indicated when precise levels that were run over the East Crossing piers from Yerba Buena Island to the Key Mole closed to within 0.01 feet of the elevation established by transbay leveling.

Precise Levels

Widespread construction activities on the Bridge required the establishment of an extensive net of bench marks from which elevations for construction purposes could be obtained. Inasmuch as the permits under which the Bridge was built specified a definite clearance above mean lower low water, it was desired to establish this datum beyond any doubt.

Accordingly, a circuit was run to Rincon Hill from the United States Coast and Geodetic Survey Bench Mark Number 166 at the Presidio, the origin of all levels for the Bridge. Bench Mark Number 166 is adjacent to the tide staff from which the tidal datum was established. From this basic circuit, levels were run to a point on Telegraph Hill where transbay levels were projected to Yerba Buena Island. In the vicinity of Rincon Hill, the base circuit was expanded into the level net covering the entire construction area in San Francisco.

The principal precise level circuit on Yerba Buena Island connected the transbay bench mark near the Goat triangulation station, with a bench mark on Army Point, from which transbay levels were projected to the East Bay. From these control bench marks the level nets were extended to include the construction area.

Transbay Levels Checked

The principal precise level circuit in the East Bay connected the transbay bench mark at the Albers Mill with the Key Route fill near the Bridge approach. A series of bench marks were then established along the fill and the shore. As a check on the transbay levels, and to tie these bench marks to stable ground, a line was run to the United States Coast and Geodetic Survey Bench Mark Number B55 in Emeryville.

In all, there were three hundred and thirty-eight bench marks established by the Bridge.

Permanent Bench Marks Established

Permanent bench marks were established on each pier of the Bridge. Precise level observations were made on these benches at frequent intervals to disclose any changes in elevations.

Where existing buildings were located close to the Bridge construction, bench marks were established and elevations were taken at regular intervals to detect any structural movement resulting from construction activities.

City and Topographic Surveys

Early in the preparations for the construction of the Bridge, it was found that no suitable large scale topographic maps were available covering the vicinity of the Bridge location. Since such maps were necessary to design and construction work, their immediate preparation was undertaken.

Construction Surveys

Triangulation was employed in progressive construction operations for the San Francisco-Oakland Bay Bridge.

West Crossing

The structures for the West Crossing were located by triangulation from stations in San Francisco and on Yerba Buena Island.

Soundings were taken of the mud line, bedrock, and cross sections of the concrete seal at Bridge pier sites. Further surveys included the establishment of elevations and lines for all construction. All piles for temporary docks used for construction operations at the piers were located by triangulation.

Concrete Anchors Located

Concrete anchors, placed to hold the floating caissons, were located in this manner.

The movements of the floating caisson, arising from ebb and flood tides, were determined by observations taken throughout twenty-four hour periods. The position of the cutting edges was established by correcting for the list and depth of caisson. Tables were prepared, based on the results of these observations, from which the increment movements of the caisson, resulting from the various tidal currents, could be predicted.

Locations of Caissons Determined

The location of the caissons required the complete coordination of twenty engineers. Communication was maintained between the land stations by a magneto telephone system and was extended to the caisson through short-wave radio sets. Each operation in the procedure was carefully planned and rehearsed beforehand. The caissons were lowered at a rate of approximately one foot in four minutes. When the caisson had been landed, with the cutting edge imbedded in mud, final observations were taken to check the cutting edge location. Cutting-edge locations were obtained at one-minute intervals when occasion demanded.

Detailed Reports on Caisson Positions

Reports on the position of the caissons were made daily as a guide to sinking operations and more frequently during critical stages. Reports were prepared from field data transmitted to the construction office by radio and magneto telephone.

After the caisson was landed on bedrock and the concrete seal had been poured, centerlines were located on top of the pier from points set by triangulation and bench marks established by projecting transbay levels from San Francisco and Yerba Buena Island. Points were set for pier forms and the locations of each anchor bolt. After the pedestals were poured, cross sections of the surfaces were taken and the tops were ground down to within one-sixteenth of an inch of the horizontal plane. Check levels were run over the area after the grinding was completed, and points were set on the centerlines of each pedestal to define steel erection.

Fourteen separate control systems were required to locate the cables of the West Crossing suspension spans. Although cable spinning did not begin until the early summer of 1935, survey studies were started late in the preceding year.

Graphs and Tables Prepared

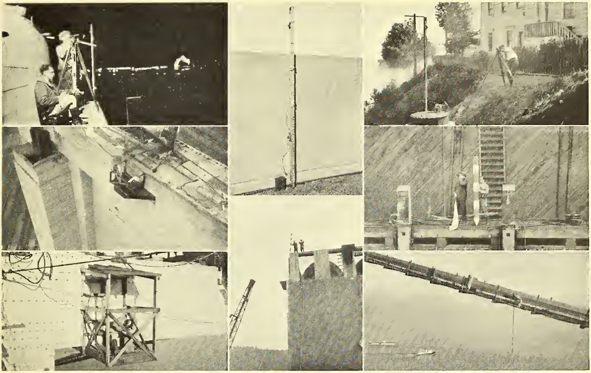
In preparing charts and graphs for this work, the curve of the free cables was assumed to be a catenary and its equation was used to compute the mid-span sags. The catenary equations, as usually found, are inconvenient for practical use, but in preparation for these cable calculations several new and convenient forms were developed.

The office problem was to prepare graphs and tables so that the cables could be adjusted to correct position by setting the midspan point at the proper elevation for any reasonable combination of temperature, span length and change in elevation of supports.

These graphs were all prepared for the centerline of the north cable and adapted for use in setting the strands of both cables by applying temperature constants. Data from the graphs were compiled in tables and bound in pocket-size volumes for convenient use in the field.

Two additional tables were required at Pier W-1 due to the slope of the rocker bent which was rotated as much as eleven degrees from the vertical during cable spinning. Any rotation of the bent produced a change in the station and elevation of the working point.

The elevation of the cables for any condition could be theoretically computed with accuracy, but the limiting factors in the field were the precision with which



Left to Right: Precise Level and Rod; Rod with Transbay Target; Precise Levels

Left to Right: Range Target, Pier W-1; Range Pole

Left to Right: Collimator Station; Range Pole, Pier W-6; Mid-span Rod

the functions, such as span length and temperature, could be measured. A study was made on a five hundred-foot model span of cable wire to evaluate these factors.

The results indicated that wind and condensation of moisture had a negligible effect on the sag.

Tower Deflections Observed

The rate and extent of tower deflections, resulting from differential temperatures in the tower legs, were determined by observing the locations of the tower tops by a vertical collimator throughout a twenty-four-hour period. Temperatures were taken of the tower steel at the same time. Differential temperatures were observed as great as forty degrees and deflections in the towers of nearly a foot parallel to the Bridge centerline and less than an inch normal to it. It was found that wind produced vibrations but no measurable deflections. Observation platforms, enclosed by canvas and roofed, were erected at desired elevation on the towers. The mid-span rods and range targets were illuminated for night work and the theodolites were equipped for electrical illumination of the cross hairs.

Permanent Telephones at Stations

Communication for survey control was maintained through magneto telephone circuits.

All observations on guide wires or strands were taken at night, for at that time the temperature of the wires could be more accurately measured and the rate of movement of towers and rockers was at a minimum. Temperatures were observed at the mid-span and near each of the towers. Guide wire temperatures were obtained from thermometers encased in short lengths of cable wire, and strand temperatures were obtained by inserting metal-encased thermometers between the wires.

Positions of Strand Shoes Checked

Upon completion of cable spinning, the final positions of the strand shoes were checked and reference points for placing cable bands and permanent splay castings were set. Points for the bands were located by measuring with a steel tape along the top of the cable.

The following table gives the results of measurements of the suspension cables made with a steel tape, and shows the divergences between measured lengths and the design length.

West Suspension Bridge Cables

Divergence Between Measured Length and Design Length

		SPAN			
Cable	*Condition*	*S. F. Anchorage to W-1*	*W-1 to W-2*	*W-2 to W-3*	*W-3 to W-4*
North	Free	+0.026 Feet	+0.006 Feet	+0.002 Feet	−0.002 Feet
	Compacted		+0.019 Feet		+0.008 Feet
South	Free	−0.005 Feet	+0.122 Feet	−0.209 Feet	0.000 Feet
	Compacted		+0.104 Feet	−0.144 Feet	+0.006 Feet

The small divergences indicate the accuracy of the instrumental control in setting the cables to the proper position, and that of the piers located by triangulation.

East Crossing

East Crossing Stations Located

East Crossing surveys were controlled by the triangulation net consisting of five stations. Two of these were on Yerba Buena Island; one on the Southern Pacific mole, 4000 feet south of the Bridge; and two on dolphins, 3000 feet north of the Bridge. The average length of sight from these stations was 5100 feet.

Guide piles for construction docks for the caissons at Piers E-3, E-4 and E-5 were located by triangulation, and sinking operations were directed by observations similarly to those for the West Crossing piers.

Cofferdam Piles Located

From Pier E-5 east the piers were constructed by the sheetpile cofferdam method. Piles for these cofferdams were located by methods similar to those used on construction docks. Working points for alignment of forms within the cofferdam were projected down from triangulated points and elevations were determined from bench marks on the completed piers or on the Key Route trestle.

After the piers were completed, a check was made of the distance between them by calibrated wire measurements, and it was found that the distance between triangulated points checked the theoretical distances to within one-quarter of an inch in all cases.

Yerba Buena Island

Prior to the start of construction activities on Yerba Buena Island, elevations were taken along the Bridge right of way, and points placed and referenced to define the location of the structures.

Cable Tunnels Calculated

During construction, the roof of the cable tunnels of the anchorage was supported by curved steel beams. Reference points for these beams were set at the spring line and at the crown.

The field calculations in the placing of these points were minimized by the use of a drawing showing a plan and elevation of the tunnel drawn to a large scale, from which angles and distances could be scaled.

Rather than cross-sectioning the side wall after excavation, a vertical contour map was made of each wall, using lines of equal distance from the centerline of the tunnel instead of lines of equal elevation.

When the anchor tunnels had been completed, steel grillages for anchoring the eyebar chains were defined for station and elevation.

Vehicular Tunnel Plotted

The roof beams of the vehicular tunnel were located by setting the bearing plates, which rested on the concrete side walls of the tunnel, to points previously established. The elevation of the beam at the centerline was then checked. Final cross sections for the roof excavation were determined by measuring radial lines from the bottom flange on these beams to the limits of excavation.

After completion of the concrete lining, a survey was made to establish lines and grades for lining the roof and side walls of the upper deck with tile.

The first step in establishing working points was a complete survey of the existing surface of the concrete lining. Although information was available on the use of pantographs for cross-sectioning tunnels, none was large enough to serve the purpose in the case of the Bridge tunnel.

Plain surveying methods were finally adopted after various studies were made. These proved to be the simplest and fastest.

The Bridge right of way traversed the area used by the Navy, and it was necessary to move several buildings and construct new roads. These alterations required careful surveys and the establishment of lines and grades for the construction were similar to those used in other classes of construction work.

Approach Surveys

The surveys for defining the location of the concrete structures forming the San Francisco approach west of Rincon Hill were based on an offset line coincident with the Harrison Street monument line. The twenty-five hundred feet of Bridge between Rincon Hill and the waterfront is supported by concrete bents, the San Francisco Anchorage, Piers A and B at Main Street and Pier W-1. The surveys for defining each of these structures were made by transit and chain, using precise methods.

Lines and grades were set for the structures of the East Bay approaches, which include the Folger Avenue Underpass, San Pablo Underpass, Distribution Structure and Toll Plaza.

The Distribution Structure presented difficulties for the re-run of curves after the start of construction due to the fact that excavated materials and the construction plant blocked the right of way. These factors dictated the use of coordinate control with permanent reference points set well back from the operations area. Before construction started the centerlines of curves were run out and checked against the computed coordinates.

Bridge Railway Surveys

The nature of the terrain and the wide scope of work to be performed for the construction of the Bridge Railway necessitated a high degree of accuracy in control and construction surveys.

Topographic surveys were made in the East Bay and San Francisco of the area to be acquired, surface and subsurface features located, and all property lines surveyed and marked. Particular attention was given to alignment of existing tracks in the Yard where such were to be affected by new construction, in order that the design of the new alignment or connections to the Bridge Railway might be facilitated.

Precise Methods Used

Bench marks were established throughout the construction area by precise level methods and frequent check runs made to correct elevations for subsidence. Elevations were transferred to structures as rapidly as pile and concrete footings were completed and level observations continued to check the stability of the footings.

Charts were prepared, upon which are recorded the elevations of each footing as observed and the subsidence graph plotted for each, so as to permit a systematic study of footing settlements.

The necessity for keeping the Key System main tracks in operation required that track be laid at random in various parts of the Yard with the assurance that the intricate system of operating tracks for the Bridge Railway, switches, storage tracks and cross-overs would fit when the final tie-ins were made. This required field work of high precision, executed promptly. Small drawings were prepared giving complete track alignment and by their use any portion of the track was staked quickly without the necessity of running tangents or curves not necessary at that time. Grades for top of the rails were also given.

Profiles Plotted for Railroad Tie Construction

Before railroad ties were placed on the Bridge, it was necessary to run profile levels on the railroad stringers. These profiles were plotted, and grade lines were established, from which the amount required to dap for each tie was determined.

Centerlines of the track were established on each floor beam.

Submarine Inspection

The foundations for all underwater structures were examined in detail by a submarine inspector. Inspections were made to depths as great as 243 feet.

He was in constant telephone communication with an engineer, who recorded his findings.

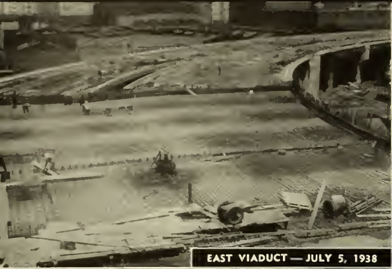
Personnel

Donald R. Warren was in direct charge of the Department of Triangulation and Surveys from January, 1933, to December, 1935. O. R. Bosso has been in charge from that date.

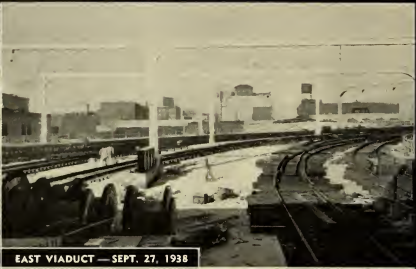
[*See page 21-A for drawings on instrument arrangement and triangulation net*]

PICTORIAL PROGRESS

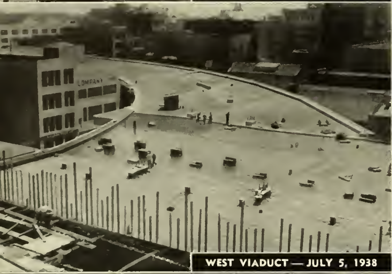
CONTRACT R-2A—SAN FRANCISCO TERMINAL, GENERAL CONSTRUCTION



EAST VIADUCT — JULY 5, 1938



EAST VIADUCT — SEPT. 27, 1938



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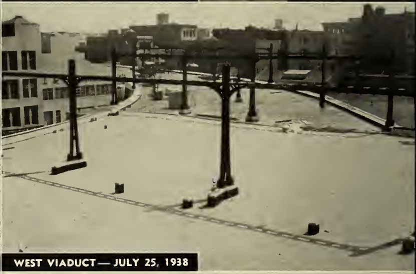

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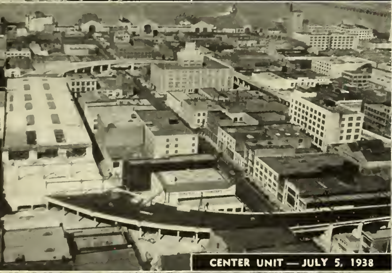
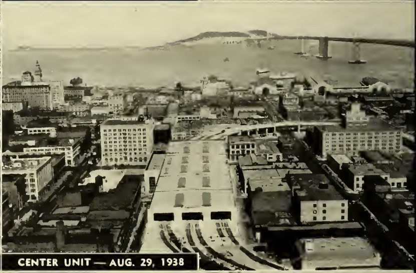


CENTER UNIT — JULY 5, 1938



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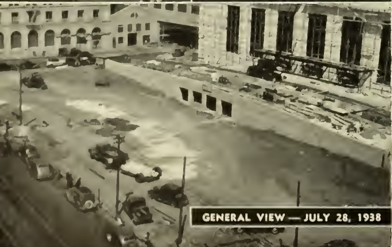
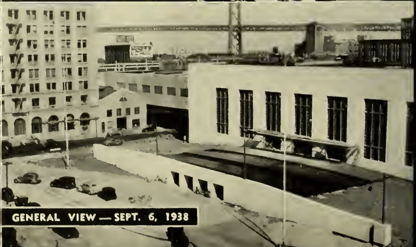
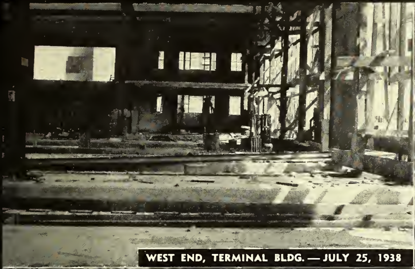


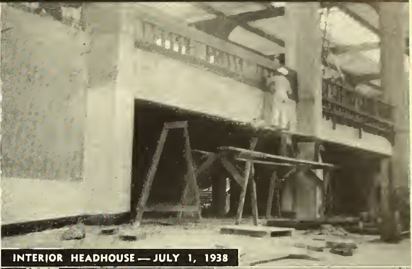
GENERAL VIEW — JULY 28, 1938

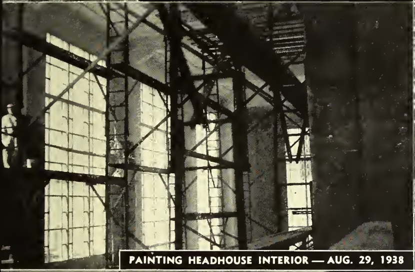


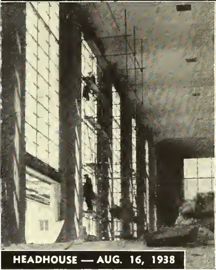
GENERAL VIEW — SEPT. 6, 1938

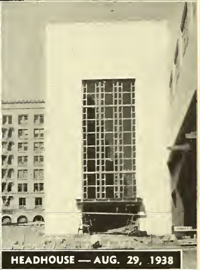
CONTRACT R2A — SAN FRANCISCO TERMINAL, GENERAL CONSTRUCTION

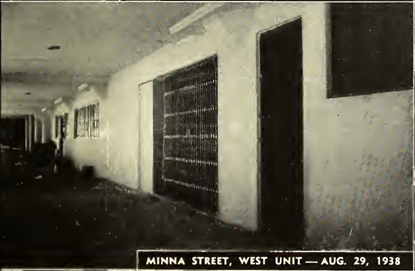

WEST END, TERMINAL BLDG. — JULY 25, 1938

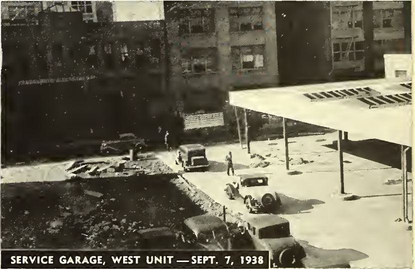

INTERIOR HEADHOUSE — JULY 1, 1938

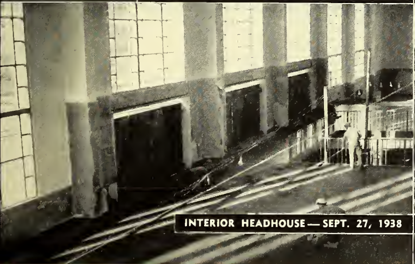

PAINTING HEADHOUSE INTERIOR — AUG. 29, 1938

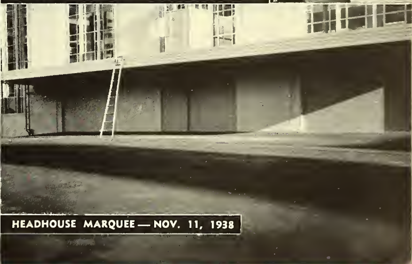

HEADHOUSE — AUG. 16, 1938


HEADHOUSE — AUG. 29, 1938

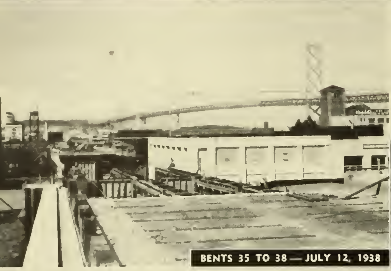

MINNA STREET, WEST UNIT — AUG. 29, 1938

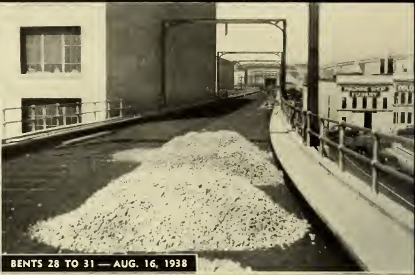

SERVICE GARAGE, WEST UNIT — SEPT. 7, 1938

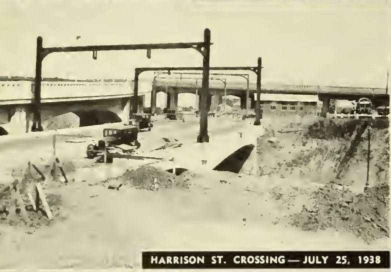

INTERIOR HEADHOUSE — SEPT. 27, 1938

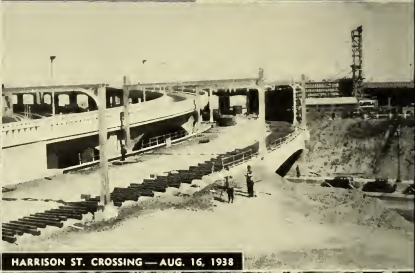

HEADHOUSE MARQUEE — NOV. 11, 1938

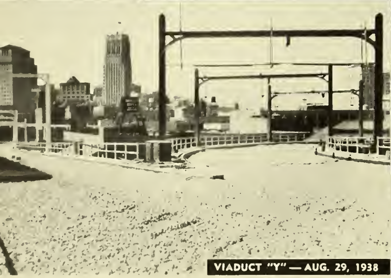
CONTRACT R-3 — SAN FRANCISCO VIADUCT

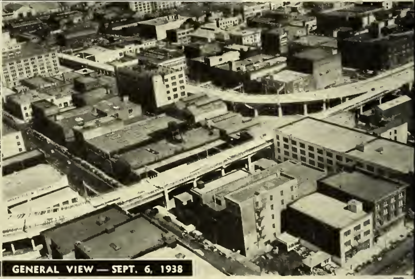

BENTS 35 TO 38 — JULY 12, 1938

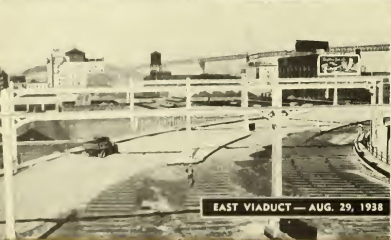

BENTS 28 TO 31 — AUG. 16, 1938

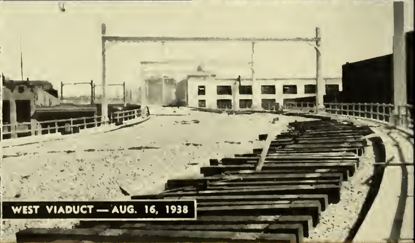

HARRISON ST. CROSSING — JULY 25, 1938


HARRISON ST. CROSSING — AUG. 16, 1938

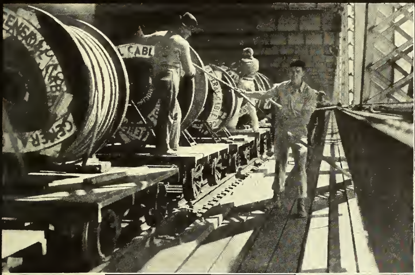

VIADUCT "Y" — AUG. 29, 1938


GENERAL VIEW — SEPT. 6, 1938


EAST VIADUCT — AUG. 29, 1938

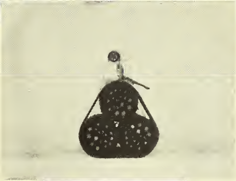

WEST VIADUCT — AUG. 16, 1938

CONTRACT R-5 — SIGNALS AND INTERLOCKING SYSTEM


CABLE LAYING — JULY 12, 1938

TEST TRAIN — SEPT. 22, 1938

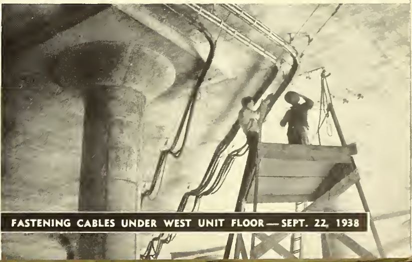
CABLES ON MESSENGER, TERMINAL — SEPT. 20, 1938


CABLE STRAP HANGAR

PLACING MESSENGER — SEPT. 16, 1938

CABLES PLACED IN CASES — SEPT. 30, 1938

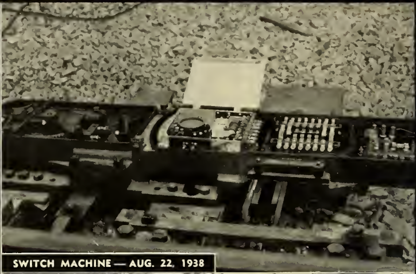
PLACING CABLE UNDER WEST UNIT FLOOR — SEPT. 16, 1938

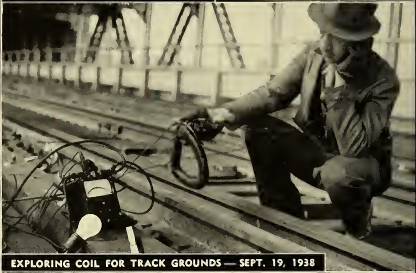

FASTENING CABLES UNDER WEST UNIT FLOOR — SEPT. 22, 1938

CONTRACT R-5 — SIGNALS AND INTERLOCKING SYSTEM

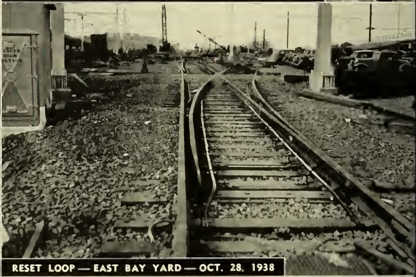
CABLES, HARRISON ST. VIADUCT

RELAY ROOM, TERMINAL


SWITCH MACHINE — AUG. 22, 1938


EXPLORING COIL FOR TRACK GROUNDS — SEPT. 19, 1938

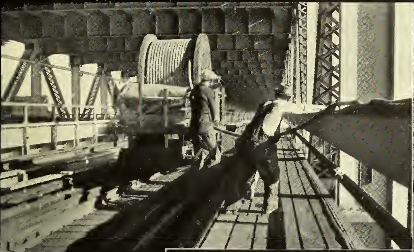
CABLES ENTERING CONTROL ROOM, TERMINAL


RESET LOOP — EAST BAY YARD — OCT. 28, 1938

POTHEADING CASES — OCT. 3, 1938

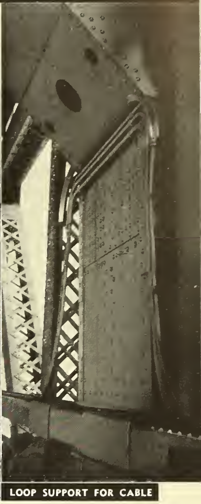
CONNECTING CASES — OCT. 14, 1938

CONTRACT R-6 — TELEPHONE SYSTEM

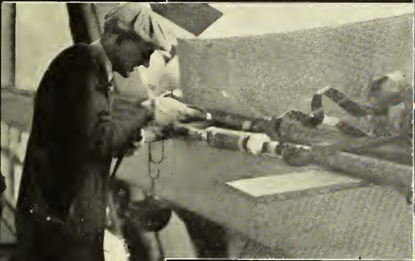


PLACING PHONE CABLE — NOV. 17, 1938

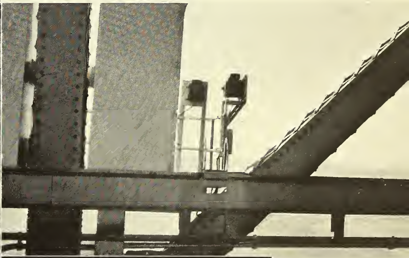
SPLICING CABLES



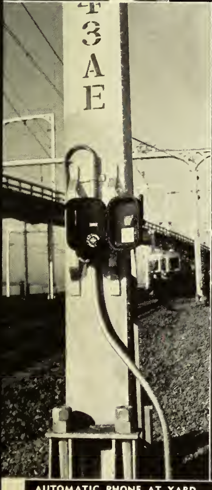
LOOP SUPPORT FOR CABLE



FINISHING SPLICE CABLES — DEC. 2, 1938

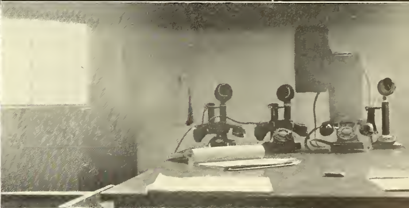


PHONES AT E-7 TIE STATION — FEB. 14, 1939



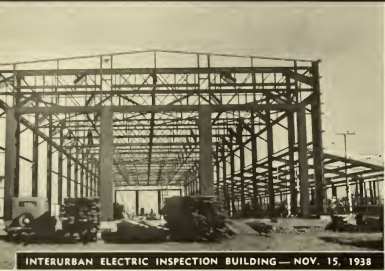
AUTOMATIC PHONE AT YARD

CROSS OVER PHONE, S. F. ANCHORAGE

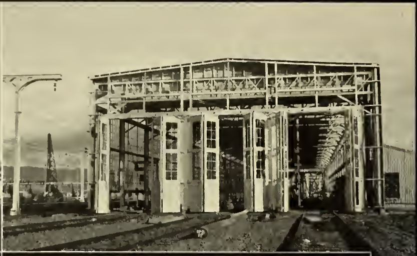


PHONES IN MOLE SUBSTATION — FEB. 14, 1939

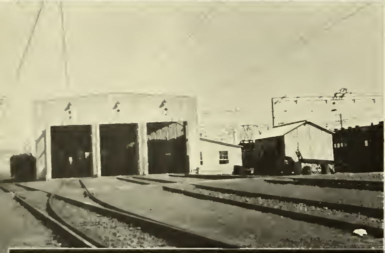
CONTRACT R-8—INSPECTION BUILDINGS



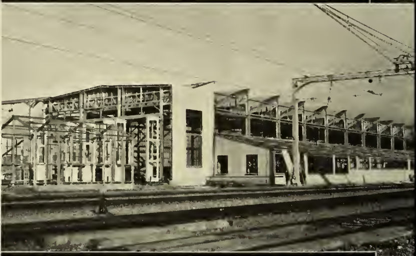
INTERURBAN ELECTRIC INSPECTION BUILDING—NOV. 15, 1938



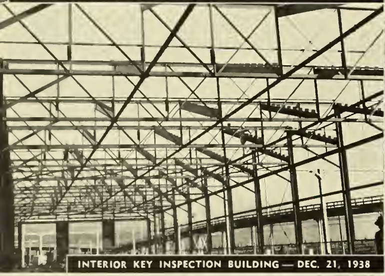
INTERURBAN ELECTRIC INSPECTION BUILDING—DEC. 21, 1938



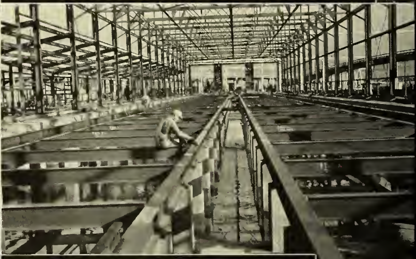
INTERURBAN ELECTRIC INSPECTION BUILDING—MARCH 16, 1939



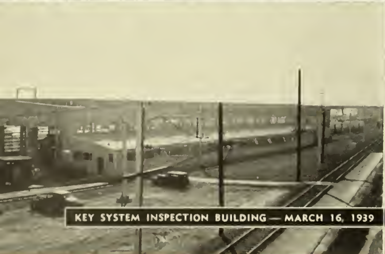
I. E. OILHOUSE AND INSPECTION BLDG.—DEC. 21, 1938



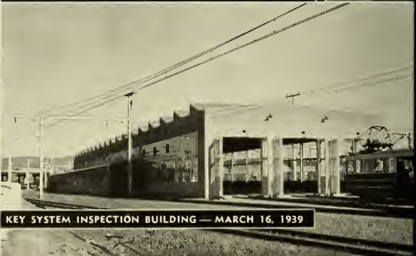
INTERIOR KEY INSPECTION BUILDING—DEC. 21, 1938



INTERIOR KEY INSPECTION BUILDING—DEC. 21, 1938

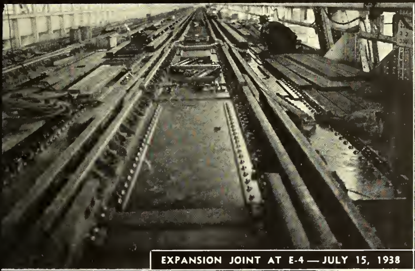


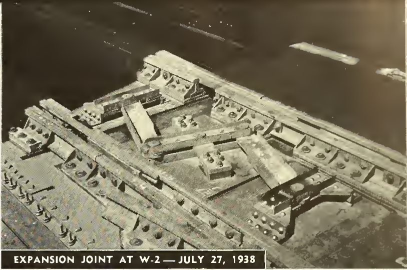
KEY SYSTEM INSPECTION BUILDING—MARCH 16, 1939

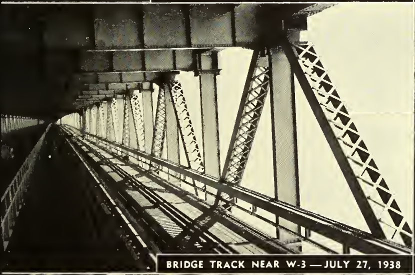


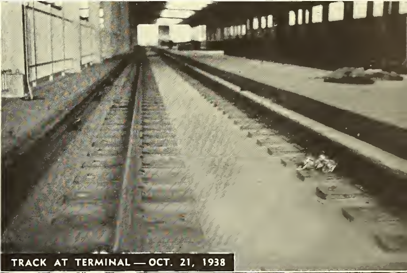
KEY SYSTEM INSPECTION BUILDING—MARCH 16, 1939

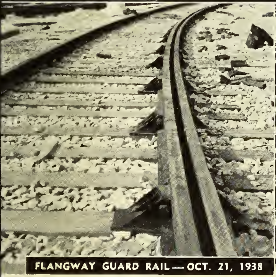
CONTRACT R-9 — TRACKWORK, BRIDGE AND LOOP

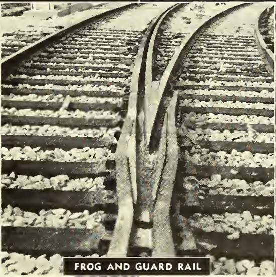

EXPANSION JOINT AT E-4 — JULY 15, 1938

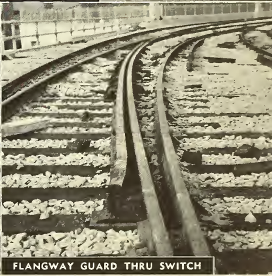

EXPANSION JOINT AT W-2 — JULY 27, 1938

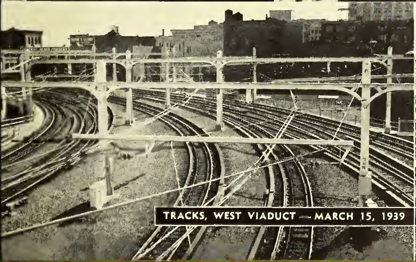

BRIDGE TRACK NEAR W-3 — JULY 27, 1938

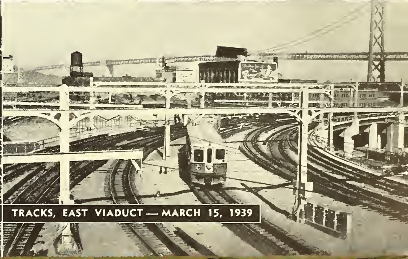

TRACK AT TERMINAL — OCT. 21, 1938


FLANGWAY GUARD RAIL — OCT. 21, 1938

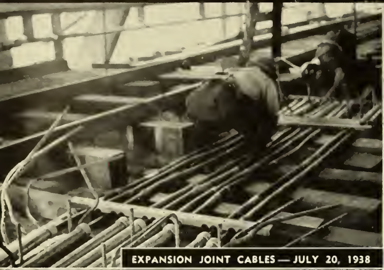

FROG AND GUARD RAIL

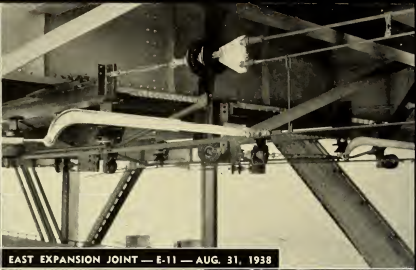

FLANGWAY GUARD THRU SWITCH

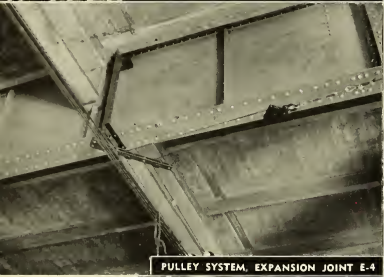

TRACKS, WEST VIADUCT — MARCH 15, 1939


TRACKS, EAST VIADUCT — MARCH 15, 1939

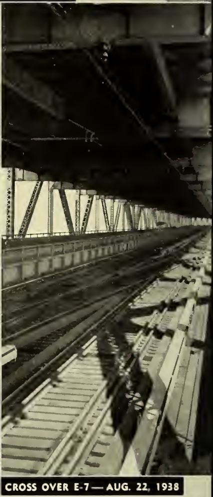
CONTRACT R-10 — CATENARY AND FEEDERS, BRIDGE AND LOOP


EXPANSION JOINT CABLES — JULY 20, 1938

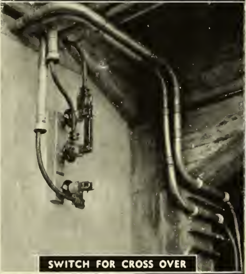

EAST EXPANSION JOINT — E-11 — AUG. 31, 1938


PULLEY SYSTEM, EXPANSION JOINT E-4

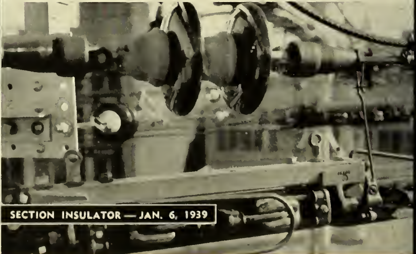
COUNTERW'TS, EXPANSION JOINTS


CROSS OVER E-7 — AUG. 22, 1938

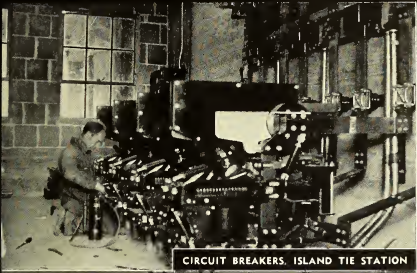
SWITCH AT E-10

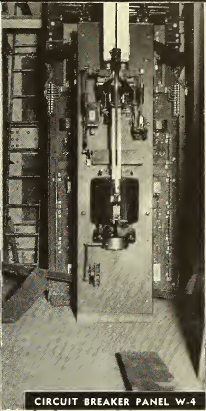

SWITCH FOR CROSS OVER

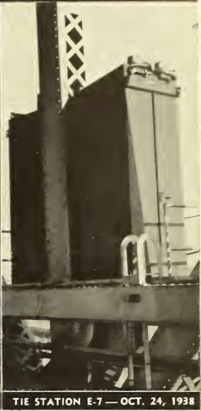
FEEDER TAPS & SECTION INSULATOR

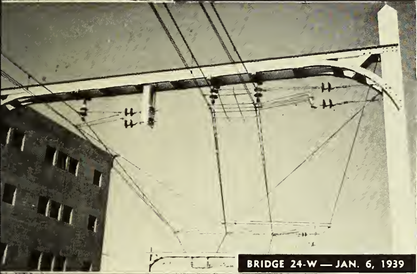

SECTION INSULATOR — JAN. 6, 1939

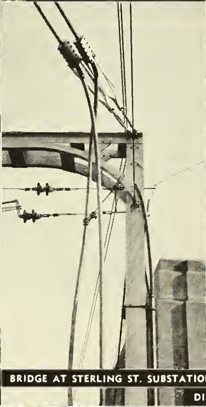
CONTRACT R-10 — CATENARY AND FEEDERS, BRIDGE AND LOOP

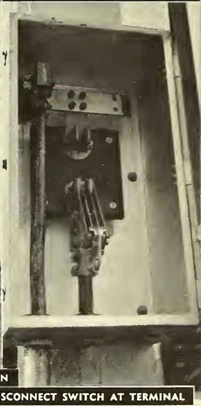

CIRCUIT BREAKERS, ISLAND TIE STATION

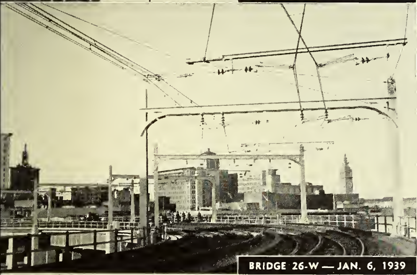

CIRCUIT BREAKER PANEL W-4

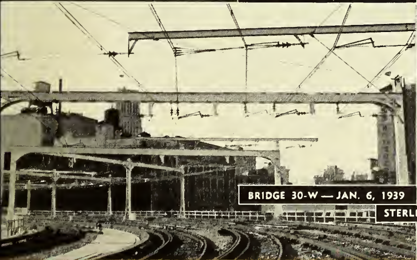

TIE STATION E-7 — OCT. 24, 1938

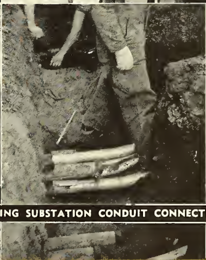

BRIDGE 24-W — JAN. 6, 1939

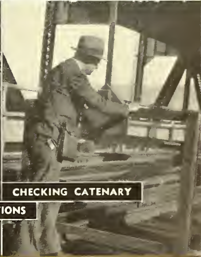

BRIDGE AT STERLING ST. SUBSTATION


DISCONNECT SWITCH AT TERMINAL


BRIDGE 26-W — JAN. 6, 1939


BRIDGE 30-W — JAN. 6, 1939


STERLING SUBSTATION CONDUIT CONNECTIONS


CHECKING CATENARY

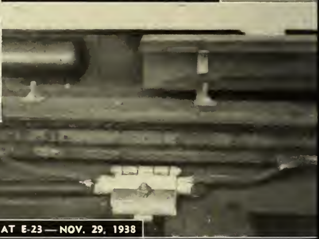
CONTRACT R-11 — TRACK BONDING, BRIDGE AND LOOP

GAS WELDING BONDS — AUG. 3, 1938

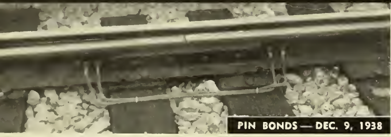
CONTACT RAIL CONDUCTIVITY TEST

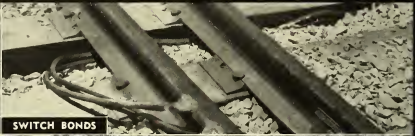
THIRD RAIL 6-IN. JACKING TEST

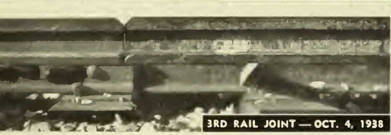
THIRD RAIL JACKED UP — OCT. 18, 1938

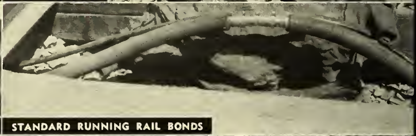

TYPE 48 BOND AT E-23 — NOV. 29, 1938

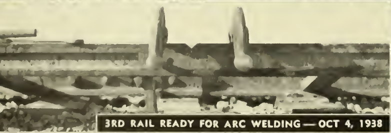
CONTRACT R-21B — TRACK BONDING, EAST BAY YARD

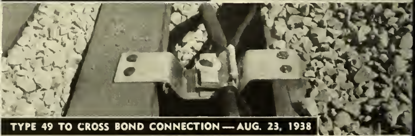

PIN BONDS — DEC. 9, 1938

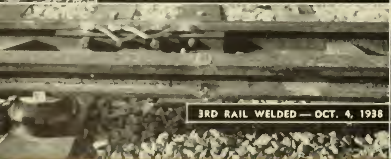

SWITCH BONDS

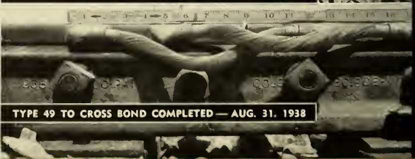

3RD RAIL JOINT — OCT. 4, 1938


STANDARD RUNNING RAIL BONDS

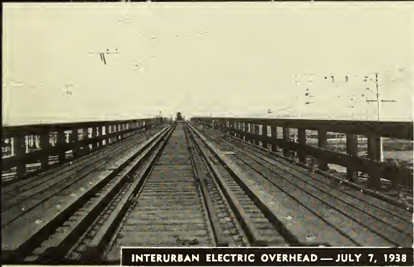

3RD RAIL READY FOR ARC WELDING — OCT 4, 1938

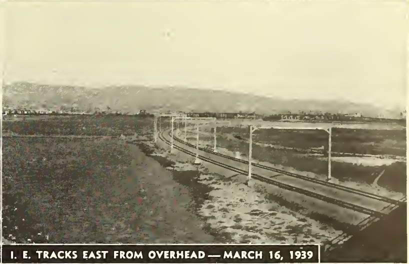

TYPE 49 TO CROSS BOND CONNECTION — AUG. 23, 1938

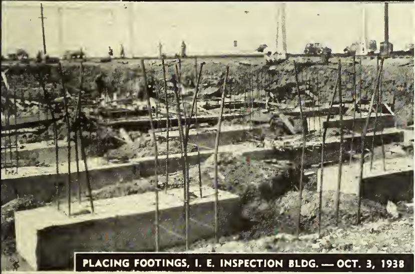

3RD RAIL WELDED — OCT. 4, 1938

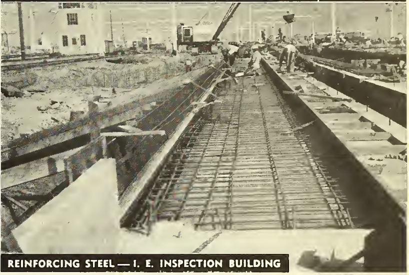

TYPE 49 TO CROSS BOND COMPLETED — AUG. 31, 1938

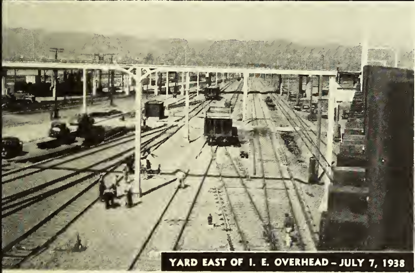
CONTRACT R-21A — TRACKWORK, EAST BAY YARD

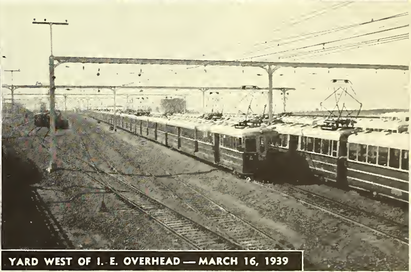

INTERURBAN ELECTRIC OVERHEAD — JULY 7, 1938

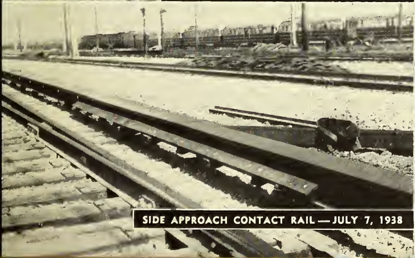

I. E. TRACKS EAST FROM OVERHEAD — MARCH 16, 1939

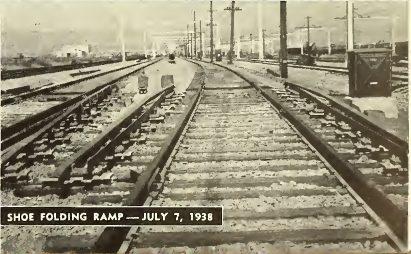

PLACING FOOTINGS, I. E. INSPECTION BLDG. — OCT. 3, 1938


REINFORCING STEEL — I. E. INSPECTION BUILDING

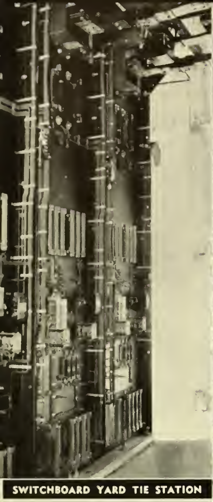

YARD EAST OF I. E. OVERHEAD - JULY 7, 1938


YARD WEST OF I. E. OVERHEAD — MARCH 16, 1939

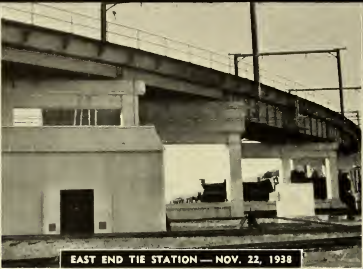

SIDE APPROACH CONTACT RAIL — JULY 7, 1938


SHOE FOLDING RAMP — JULY 7, 1938

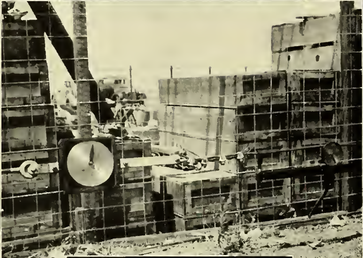
CONTRACT R-21C — CATENARY AND FEEDER SYSTEM, EAST BAY YARD



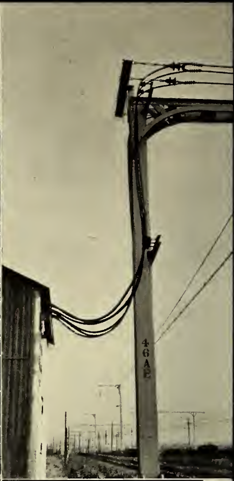
SWITCHBOARD YARD TIE STATION



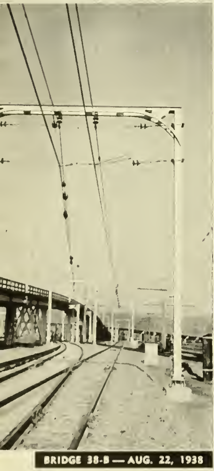
EAST END TIE STATION — NOV. 22, 1938



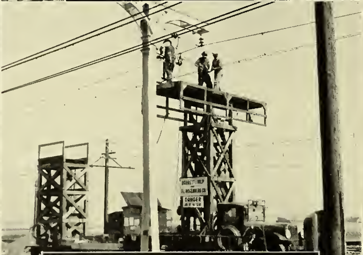
TENSION GAUGE "ON" — AUG. 3, 1938



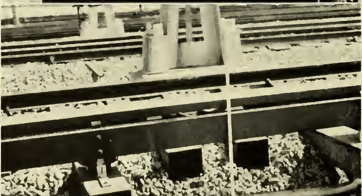
YARD TIE STATION — FEB. 3, 1939



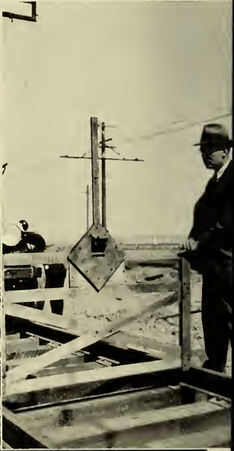
BRIDGE 38-B — AUG. 22, 1938



CONTRACTORS TOWER TRUCK — JULY 27, 1938

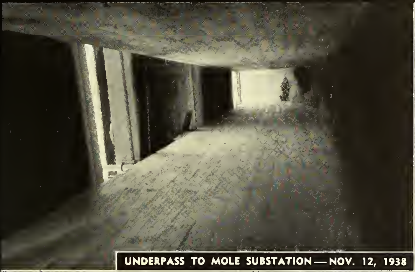


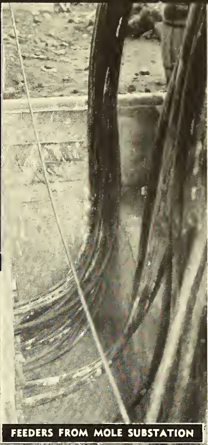
CONDUIT FOR THIRD RAIL — AUG. 3, 1938

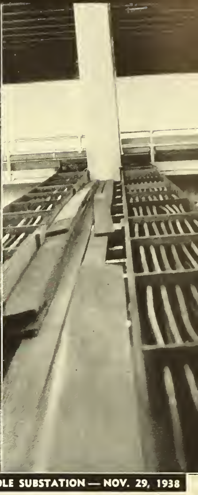


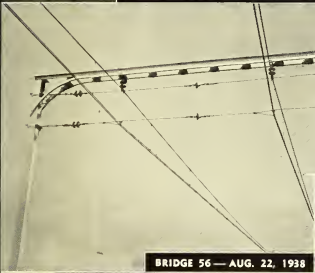
SIGHTING DEVICE — JULY 27, 1938

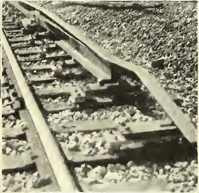
CONTRACT R-21C — CATENARY AND FEEDER SYSTEM, EAST BAY YARD

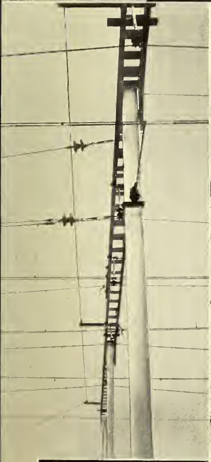

UNDERPASS TO MOLE SUBSTATION — NOV. 12, 1938

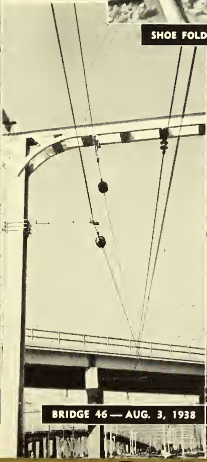

FEEDERS FROM MOLE SUBSTATION

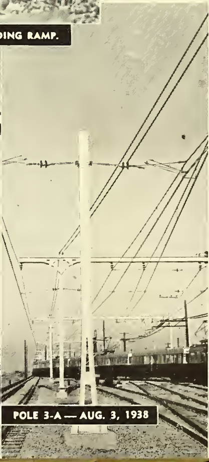

FEEDERS FROM MOLE SUBSTATION — NOV. 29, 1938

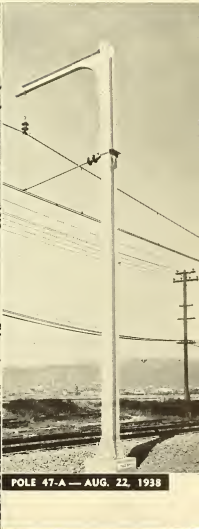

BRIDGE 56 — AUG. 22, 1938


SHOE FOLDING RAMP.


BRIDGE 36 — JULY 28, 1938
(NOTE CONTACT WIRE)

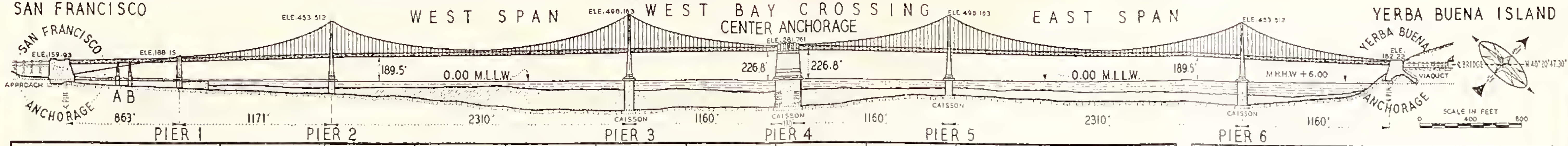

BRIDGE 46 — AUG. 3, 1938


POLE 3-A — AUG. 3, 1938


POLE 47-A — AUG. 22, 1938

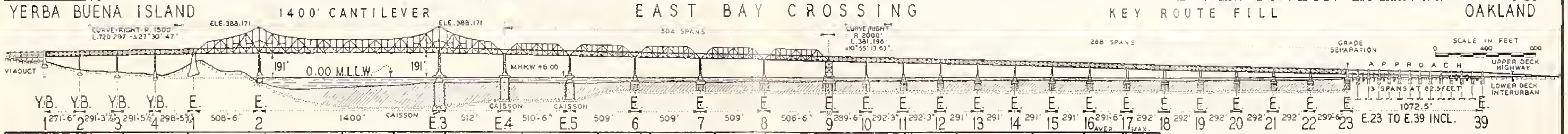
MAPS AND DRAWINGS

TABULATION OF BIDS



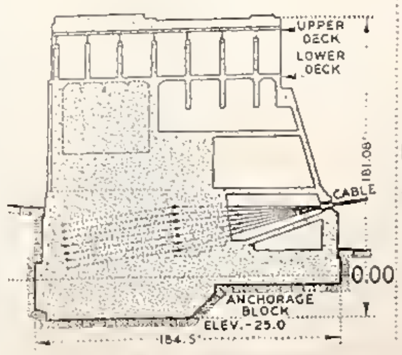
ELEVATIONS	S.F. ANCHORAGE	PIER A	PIER B	PIER 1	PIER 2	PIER 3	PIER 4	PIER 5	PIER 6	Y.B. ANCHORAGE
MUD LINE OR GROUND LINE	+29 TO +12	+16	+18	+12	-50	-73	-70	-68	-113	+190 TO +80
ROCK LEVEL	25 TO -05	-35 TO -70	-40 TO -50	-20 TO -61	-80 TO -98	-218 TO -228	-215 TO -221	-106 TO -115	-167 TO -176	+130 TO +70
DESIGN LEVEL OF PIER EXCAVATION	-30 TO -05	-15	-15	-60	-83 TO -100	-218 TO -228	-187 TO -210	-105 TO -117	-175 TO -183	+104 TO +5⊕
DESIGN LEVEL OF CUTTING EDGE						CONTR. ELEV. -206 LANDED ELEV. -223.6	CONTR. ELEV. -170 LANDED ELEV. -210.3	CONTR. ELEV. -95 LANDED ELEV. -106.9	CONTR. ELEV. -160 LANDED ELEV. -161.5	⊕ BOTTOM OF CABLE TUNNELS
TOP OF CAISSON		-9.5 TOP FTG.	-10 TOP FTG.	-20 TOP FTG.	+12.87 TOP FTG.	+25	+25	+25	+25	
TOP OF MASONRY	+159.93	+25.13	+28.00	+188.40	+40	+40	+235.18	+40	+40	+182.22
BOTTOM CHORD					+180.72				+180.72	
NORTH GUTTER LINE - LOWER DECK	+125.459	+136.798	+139.669	+151.338	+186.468	+231.145	+234.343	+231.145	+186.468	+151.668
NORTH GUTTER LINE - UPPER DECK	+151.876	+163.215	+166.086	+177.755	+212.885	+257.562	+260.760	+257.562	+212.885	+178.085
CABLE	+20.37 AT ANCHOR GIRDERS			+183.343	+457.791	+502.402	+267.428	+502.402	+457.791	182.35 AT CABLE BENT ℄ 19.469 AT ANCHOR GIRDERS
PLAN DATA										
PLAN DIMENSIONS OF CAISSON	184'-6" × 108'-0"	28' × 104'-3"	28' × 104'-8"	56' × 112'	52'-0" × 121'-4"	74'-6" × 127'-0"	197'-0" × 92'-0"	57'-0" × 127'-0"	74'-6" × 127'-0"	156'-6" × 101'-9"
TYPE OF CAISSON		LAND COFFERDAM	LAND COFFERDAM	LAND COFFERDAM	SHEET PILE COFFERDAM	DOME	DOME	DOME	DOME	
NUMBER OF WELLS						4 × 7 = 28	5 × 11 = 55	3 × 7 = 21	4 × 7 = 28	
SIZE OF WELLS						15'Φ	15'Φ	15'Φ	15'Φ	
AREA OF CAISSON - IN SQUARE FEET	19000	2919	2931	6272	6309	9462	18124	7239	9462	
AREA OF WELLS - IN SQUARE FEET						4948	7599✢	3711	4948	✢ NOTE - 12 CORNER WELLS FILLED WITH CONCRETE
CONCRETE AREA - PER CENT OF TOTAL					100	42.8 TO 42.3	54.3 TO 58.1	42.8	42.8 TO 42.3	
CONCRETE - CU. YDS. PER VERTICAL FOOT						150.0 TO EL. -79.0 127.9 ABOVE	365.0 TO EL. -92.8 359.8 ABOVE	114.8 TO EL. -1.5 131.0 ABOVE	150.0 TO EL. -25.0 131.9 ABOVE	
PERIMETER OF CAISSON						403'	578'	368'	403'	
PLAN DIMENSIONS OF FENDER						109'-9" × 189'-3"	236'-3" × 141'-3"	96'-3" × 186'-3"	103'-9" × 186'-3"	
LOADING DATA										
DEAD LOAD IN TONS	1380	3920	3920	8130	22750	22700	440	22700	22750	
LIVE LOAD IN TONS	3670				7990	7980	220	8020	8020	
TOWER LOAD IN TONS					4790	5290		5290	4790	
PIER SHAFT IN TONS	133190	3065	3065	42990	4700	3000	93300	3000	3000	
CAISSON IN TONS					50240	125000	232310	64050	105200	
TOTAL IN TONS	130900	6985	6985	51120	90470	163970	326270	103060	143760	
BUOYANCY IN TONS	10450	995	995	11400	18600	66100	104500	24300	51500	
NET LOAD ON ROCK IN TONS	120450	5990	5990	39720	71870	97870	221770	78760	92260	
AVER. LOAD ON ROCK TONS PER SQ. FT.	6.3	2.0	2.0	6.7	[illegible]	10.3	12.2	10.9	9.75	
MAX. LOAD ON ROCK TONS PER SQ. FT.	10.4			9.4	21.5	41.0	51.3	22.0	27.2	

MISCELLANEOUS DATA	
GENERAL	
LENGTH OF PROJECT	
SAN FRANCISCO TERMINAL TO S.F. ANCHORAGE	4200 FT.
WEST BAY CROSSING	10450 "
YERBA BUENA ISLAND CROSSING	2950 "
EAST BAY CROSSING TO TOLL PLAZA	19400 "
TOLL PLAZA TO OAKLAND TERMINAL	6500 "
TOTAL	43500 FT.
QUANTITIES	
STRUCTURAL STEEL	149000 TONS
CABLE WIRE	20500 TONS
REINFORCING STEEL	37000 "
MISCELLANEOUS METAL WORK	29000 "
CONCRETE	900000 CU.YD.
CEMENT	1250000 BBLS.
TIMBER	25000000 F.B.M.
PILES TIMBER & CONCRETE	1166000 LIN.FT.
PAINT	120000 GALS.
TOTAL ESTIMATED COST	$75000000
WEST BAY CROSSING	
NUMBER OF CABLES	2
DIAMETER OF CABLES	28¾"
NUMBER OF WIRES IN EACH CABLE	17464
DIAMETER OF EACH WIRE	0.195"
TOTAL LENGTH OF CABLE WIRE	70815 MILES
ROADWAY	
UPPER DECK - 6 LANE HIGHWAY - BETWEEN CURBS	58 FT.
LOWER DECK - 3 LANE HIGHWAY - BETWEEN CURBS	31 FT.
LOWER DECK - DOUBLE TRACK INTERURBAN LINES - ELECTRIC 13'-0" ON ℄	20'-0" HEADROOM
CLEARANCES	
AT CENTER OF CENTER SPAN	209'
AT CENTER ANCHORAGE	226.8'
AT 1400' CANTILEVER - EAST BAY	191'
NOTE: 0.00 M.L.L.W.	+6.00 M.H.H.W.

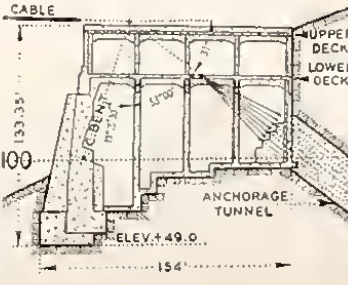


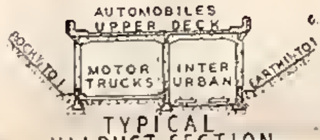
PIER NO.	TYPE OF FOUNDATION	GROUND OR MUD LINE	BOT. OF FOOT'G. OR PILE CAP	TOP OF FOOT'G. OR PILE CAP	TOP OF MASONRY	LANDED C.E. LEVEL	PLAN DIMENSIONS	AREA OF CAISSON	PERIMETER CAISSON	NO. & SIZE OF WELLS	AREA OF WELLS	AREA CONCRETE	SIZE AND TYPE OF PILES	NUMBER OF PILES	AVER. PILE LGTH. AVER. ELEV. TIP	NET LOAD AT BASE OF FOUNDATION IN TONS	INTENSITY VERT. LOAD TONS/SQ.FT. OR/PILE	INTENSITY EARTH QK. TONS/SQ.FT. OR/PILE
Y.B.-1	HOLLOW CYLINDER	+151 TO +90	+03 N. +065	+133 N. +90 S.	+204.58		2 CYL. 24' DIAM.											
Y.B.-2	SPREAD FOOTING	+67 TO +30	+25 N. +25 S.	+62 N. +62.5	+62		43'-0" Ⓝ Ⓢ 43'-0"											
Y.B.-3	SPREAD FOOTING	+40 TO +30	+20 N. +10.0 S.	+43 N. +43 S.	+43		38'-6" ○ ○ 43'-0"									5400	2.0	3.5
Y.B.-4	SPREAD FOOTING	+47 TO +09	+15.5 N. -16 S.	+47 N. +47.5	+47		18x16 □ □ 21'x22'									6500	8.3	15.0
E.-1	SPREAD FOOTING	+104 TO +20	+51.5 N. +10.5		+180.56		20'x68' N 20'x78' S									27350	6.6	26.8
E.-2	STEEL SHEETING COFFERDAM	-07 TO -28	-37 TO -56.6		+40		42'-9" × 121'-5"									39450	7.6	15.1
E.-3	OPEN DREDGED FALSE BOTTOM	-40	-232 TO -242		+40	-228.23	80'-1"x134'-0" AT C.E. 79'-5"x133'-10" CONC.	10323 □' ABOVE C.E.	397'	4 × 7 = 28 AT 15'-7½"x15'-5"	6529□'	3794□'				73200	7.0	26.3
E.-4	OPEN DREDGED FALSE BOTTOM	-38	-172 TO -184		+30	-171.48	60'-1"x90'-4¼" AT C.E. 59'-5"x89'-0¾" CONC.	5252 □' ABOVE C.E.	284'	3 × 5 = 15 AT 14'-10"x13'-6¾"	2974□'	2278□'				30000	5.6	27.5
E.-5	OPEN DREDGED FALSE BOTTOM	-40	-174 TO -182		+30	-169.12	60'-1"x90'-4¾" AT C.E. 59'-5"x89'-8¾" CONC.	5252 □' ABOVE C.E.	284'	3 × 5 = 15 AT 14'-10"x13'-6¾"	2974□'	2278□'				30500	5.7	21.8
E.-6	PILE FOOTING	-35	-50	-33	+25		68' × 128'						DOUGLAS FIR	544	85' ELEV. -125	21200	37.0	61.4
E.-7	" "	-25	-50	-33	+25		68' × 128'						" "	544	85' ELEV. -125	21200	37.0	61.4
E.-8	" "	-11	-50	-32	+25		68' × 128'						" "	544	85' ELEV. -125	21200	37.0	61.4
E.-9	" "	-11	-45	-29	+25		100' × 100'						" "	625	85' ELEV. -122	23600	35.8	74.7
E.-10	" "	-11	-45	-29	+25		44' × 112'						" "	308	85' ELEV. -119	11300	34.6	74.5
E.-11	" "	-10	-45	-29	+25		48' × 108'						" "	324	OUTSIDE 50' EL. -89 OTHERS 85' EL. -116	11800	34.4	71.6
E.-12	" "	-11	-45	-29	+25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -115	10900	34.7	80.4
E.-13	" "	-11	-45	-29	+25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -119	10900	34.7	79.2
E.-14	" "	-11	-45	-29	+25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -119	10900	34.7	78.0
E.-15	" "	-11	-45	-29	+25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -118	10900	34.7	76.8
E.-16	" "	-11	-45	-29	+25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -114	10850	34.5	75.7
E.-17	" "	-10	-45	-29	+61.25		48' × 108'						" "	324	OUTSIDE 85' EL. -117 OTHERS 85' EL. -120	12340	36.1	78.3
E.-18	" "	-10	-45	-29	+53.25		48' × 108'						" "	324	OUTSIDE 50' EL. -91 OTHERS 85' EL. -121	12340	36.1	78.3
E.-19	" "	-10	-45	-29	+45.25		48' × 108'						" "	324	OUTSIDE 50' EL. -89 OTHERS 85' EL. -118	12340	36.1	78.3
E.-20	" "	-11	-45	-29	+37.25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -117	11080	35.3	74.5
E.-21	" "	-11	-45	-29	+29.25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -114	11080	35.3	74.5
E.-22	" "	-11	-45	-29	+21.25		44' × 108'						" "	297	OUTSIDE 50' EL. -89 OTHERS 85' EL. -114	11080	35.3	74.5

SAN FRANCISCO ANCHORAGE

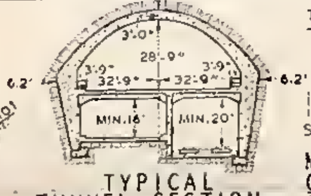


YERBA BUENA ANCHORAGE

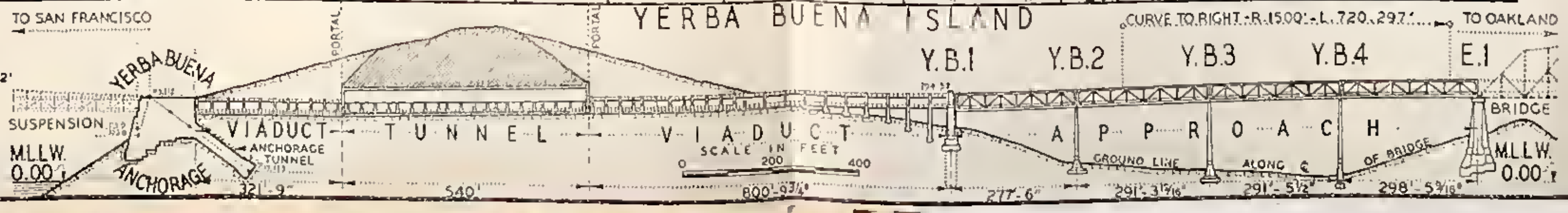




TYPICAL VIADUCT SECTION



TYPICAL TUNNEL SECTION



STATE OF CALIFORNIA

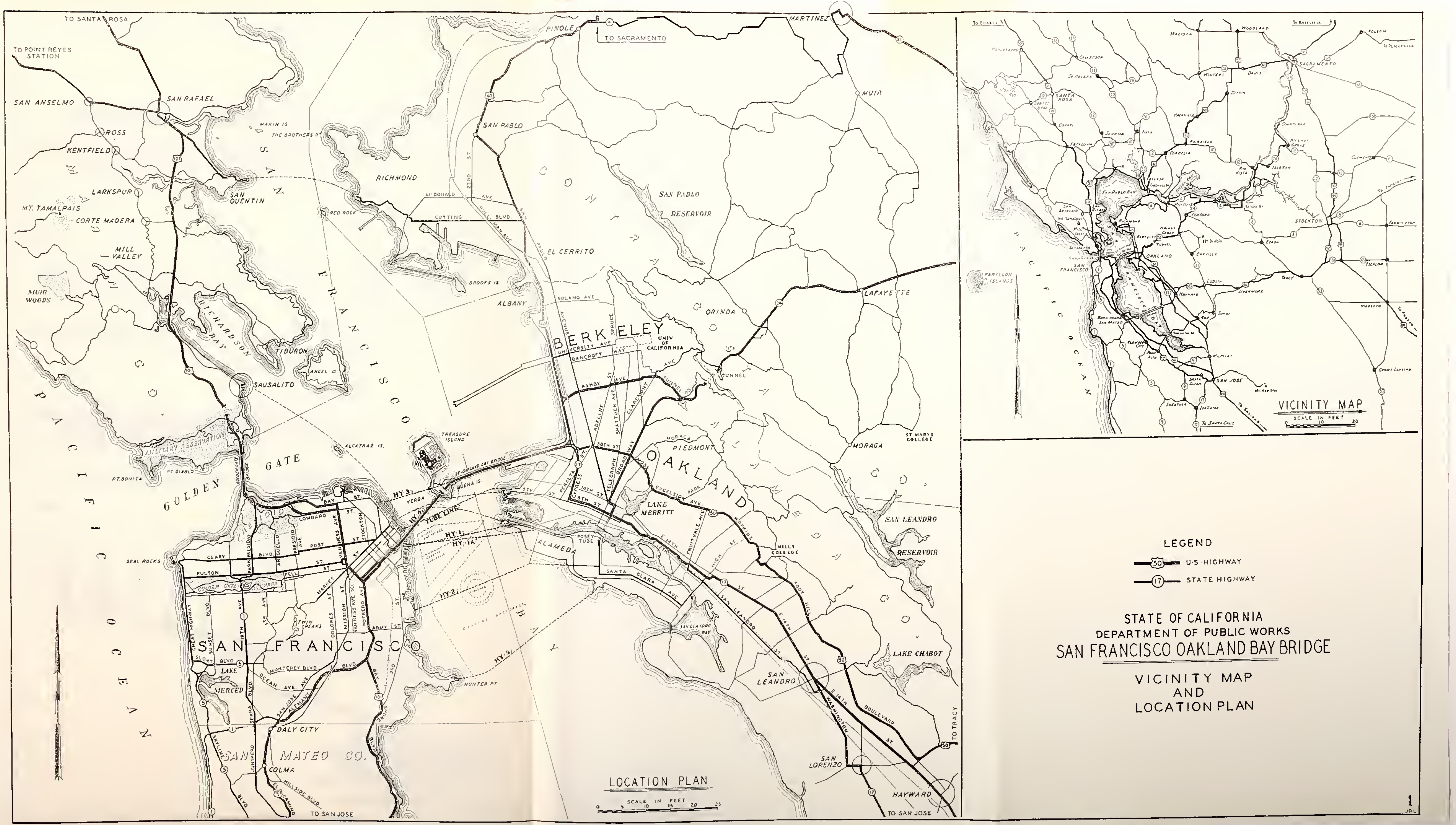
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE

WEST BAY CROSSING
YERBA BUENA CROSSING
EAST BAY CROSSING
- GENERAL DATA -

SCALE AS NOTED
OCTOBER 1939

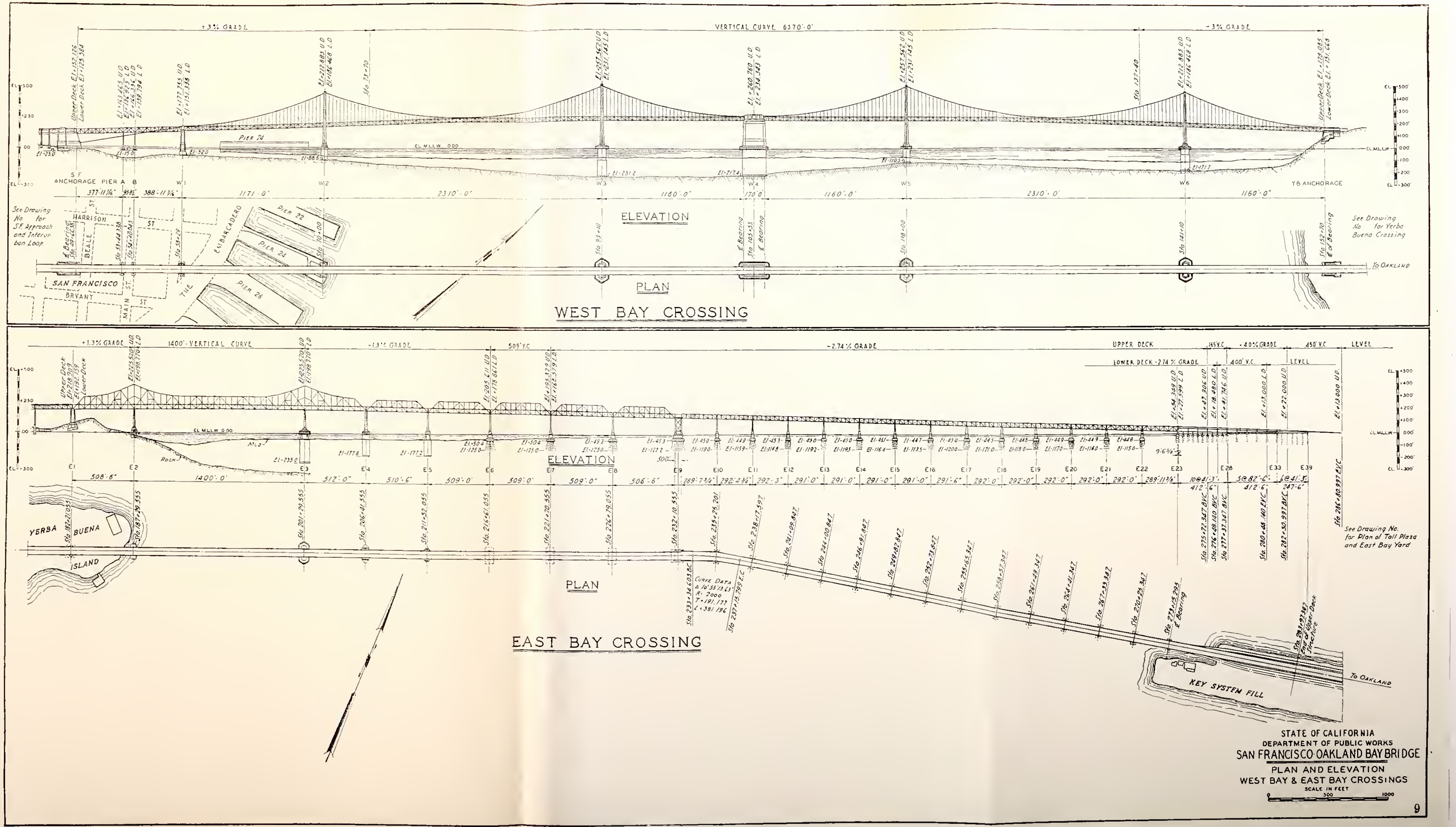
Vicinity Map and Location
Plan and Elevation



STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO OAKLAND BAY BRIDGE

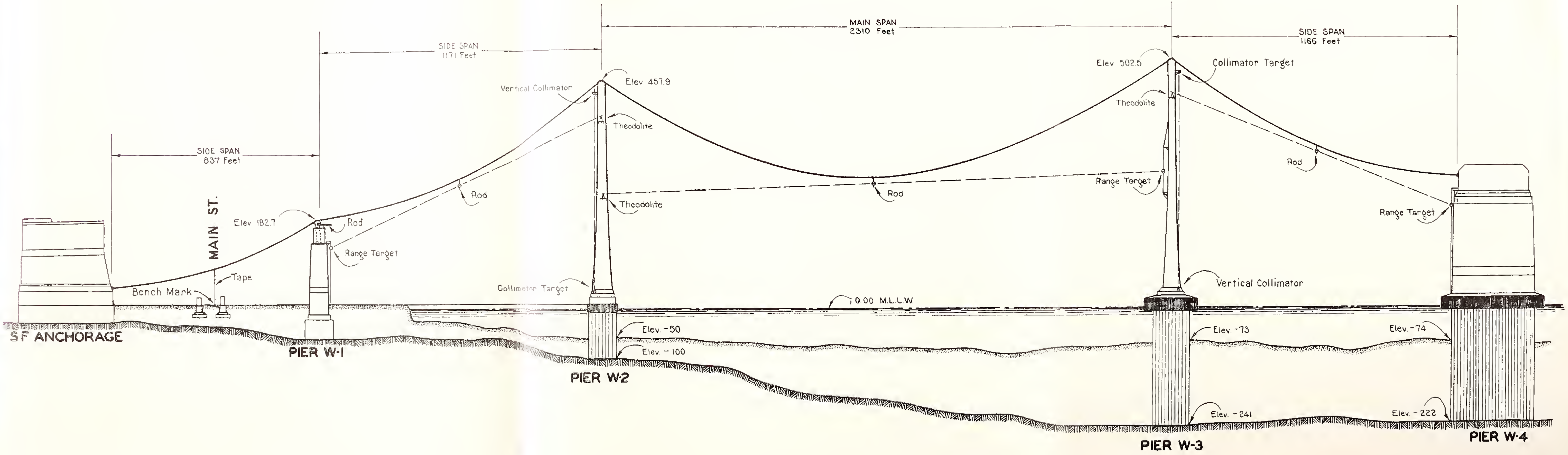
VICINITY MAP
AND
LOCATION PLAN

19-A—General Data
Vicinity Map and Location
Plan and Elevation



STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE
PLAN AND ELEVATION
WEST BAY & EAST BAY CROSSINGS
SCALE IN FEET
0 500 1000

19-A—General Data
Vicinity Map and Location
Plan and Elevation

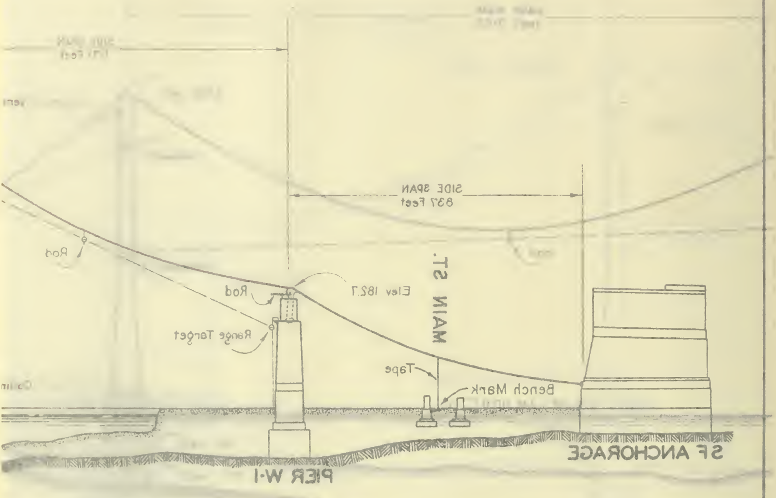


SCALE
Hor. 1 inch = 300 feet
Vert 1 inch = 150 feet

NOTES

At each tower and at midspan,Fahrenheit thermometers,encased in cable wire, are to be placed parallel to the cable.
Instruments, cross hairs and verniers shall be electrically illuminated
Instruments shall be set at a predetermined elevation.
Rods and targets shall be defined by red and white electric bulbs.
Rods at midspan are to be of constant length.
The range targets shall be adjusted to line-in the rod at midspan to the desired elevation.
Communication,between control points of each span,will be by telephone.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE
TRIANGULATION & SURVEYS
INSTRUMENT ARRANGEMENT
FOR
ALIGNMENT OF CABLES
DATE 4·2·35 BY ERB CH. ______ NO. ______
APPROVED D.R. Warren



NOTES

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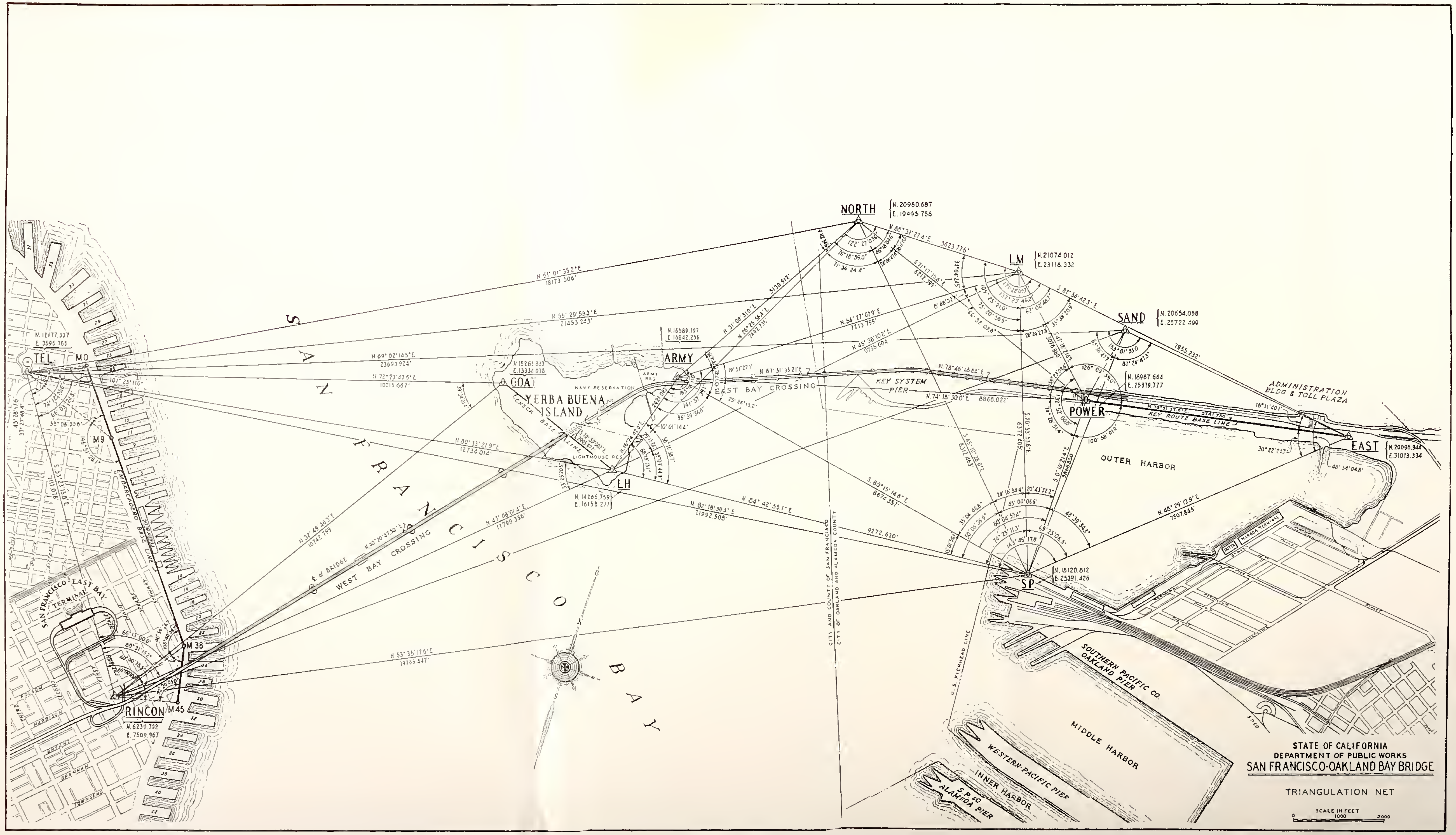

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE

TRIANGULATION NET

Triangulation: Instrument Arrangement
Triangulation Net

23-A—Telephone System (Contract No. R-6)

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO OAKLAND BAY BRIDGE

BIDS OPENED 2:00 P.M. OCTOBER 19, 1938
RM. 811 - 500 SANSOME ST., SAN FRANCISCO

RAILWAY FACILITIES
TELEPHONE SYSTEM
CONTRACT Nº R6

TABULATION OF BIDS

ITEM	APPROX. QUAN.	DESCRIPTION	ABBETT ELECTRIC CO. 126 SEAR ST. SAN FRANCISCO		GEORGE F. BRAYER. 166 - 7TH ST. SAN FRANCISCO		RADELFINGER BROS. 544 NATOMA ST SAN FRANCISCO.		BARRETT & HILP. 918 HARRISON ST. SAN FRANCISCO	
		BIDDERS BOND					$30.000 ºº			
		CERTIFIED CHECK	$1650 ºº		$1950 ºº				$3000 ºº	
			UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL
1		*Installation of Cable. Lump Sum*		6672 00		9720 00		11258 60		12300 00
2		*Furnishing and placing Cable Accessories and Branch Wiring, Lump Sum*		4896 00		3023 00		3900 00		5600 00
3	7	*Type A Local Battery Magneto Subscriber Sets.*	73 00	511 00	49 49	346 43	46 80	327 60	67 00	469 00
4	1	*Type B Local Battery Magneto Subscriber Sets.*	46 00	46 00	70 10	70 10	46 80	46 80	43 00	43 00
5	9	*Type C Local Battery Magneto Subscriber Sets.*	78 00	702 00	78 08	702 72	78 00	702 00	100 00	900 00
6	5	*Type D Local Battery Magneto Subscriber Sets.*	34 00	170 00	38 85	194 25	40 00	200 00	47 00	235 00
7	15	*Type E Central Battery Subscriber Sets.*	30 00	450 00	31 79	476 85	33 00	495 00	33 00	495 00
8	4	*Type F Central Battery Subscriber Sets.*	85 00	340 00	83 82	335 28	86 00	344 00	105 00	420 00
9	11	*No. 10 Cable Terminal Boxes.*	35 00	385 00	62 00	682 00	16 00	176 00	28 00	308 00
10	5	*No. 26 Cable Terminal Boxes.*	55 00	275 00	72 98	364 90	32 00	160 00	28 00	140 00
11	1	*No. 51 Cable Terminal Boxes.*	226 00	226 00	229 84	229 84	200 00	200 00	230 00	230 00
12	1	*PBX Switchboard.*	1251 00	1251 00	1318 84	1318 84	1330 00	1330 00	1350 00	1350 00
13	1	*Lot Miscellaneous Work.*		480 00		1039 00		780 00		440 00
		TOTAL		$16,404 00		$18,503 21		$19,920 00		$22,930 00

21-A—Triangulation: Instrument Arrangement
Triangulation Net

23-A—Telephone System (Contract No. R-6)

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO OAKLAND BAY BRIDGE

BIDS OPENED 2:00 P.M. AUGUST 3 1938
RM 811 - 500 SANSOME ST., SAN FRANCISCO

RAILWAY FACILITIES
INSPECTION BUILDINGS
CONTRACT NO. R8

TABULATION OF BIDS

ITEM	APPROXIMATE QUANTITY	DESCRIPTION	FRED J. EARLY JR. 369 PINE STREET SAN FRANCISCO		BARRETT & HILP 918 HARRISON ST. SAN FRANCISCO		BATES & ROGERS CONST. CO. P.O. BOX 1018 OAKLAND		CLINTON CONST. CO. OF CALIF. 923 FOLSOM ST. SAN FRANCISCO.	
		BIDDERS BOND	$ 15.000.00				$ 20.000.00			
		CERTIFIED CHECK			$ 14.000.00				$ 15.000.00	
			UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL
1	10	Cubic Yards of Concrete	50.00	500.00	30.00	300.00	44.60	446.00	32.00	320.00
2	1500	Pounds Reinforcing Steel	.10	150.00	.05	75.00	.055	82.50	.06	90.00
3	25	Thousand Feet Board Measure Timber - Untreated	54.00	1350.00	60.00	1,500.00	67.00	1675.00	60.00	1,500.00
4	5	Thousand Feet Board Measure Timber - Creasoted	120.00	600.00	100.00	500.00	121.00	605.00	86.00	430.00
5	660000	Pounds Structural Steel	.055875	36,877.50	.058	38,280.00	.055	36,300.00	.06	39,600.00
6		Corrugated Asbestos Roofing and Siding. Lump Sum		22,800.00		15,000.00		19,300.00		21,300.00
7		Steel Window		6,675.00		6,700.00		7,587.00		7,050.00
8		Rough Carpentry		8,500.00		10,500.00		9,830.00		7,200.00
9		Finish Carpentry		5,000.00		3,000.00		7,465.00		4,600.00
10		Roofing		3,500.00		3,500.00		3,449.00		3,300.00
11		Glass and Glazing		5,000.00		4,800.00		5294.00		4,700.00
12		Mastipave Flooring		400.00		450.00		390.00		400.00
13		Painting		6000.00		6,500.00		7150.00		7,500.00
14		Finish Hardware		3000.00		3,500.00		3372.00		3,100.00
15		Plumbing		12,200.00		15,000.00		13583.00		14,600.00
16		Electrical Work		15,000.00		15,000.00		14638.00		16,000.00
17		Sheet Metal		2,000.00		7,500.00		1086.00		1,400.00
18		Metal Partitions		1,500.00		1,500.00		1450.00		1,500.00
19		Lathing and Plastering		1,100.00		1000.00		797.00		900.00
20		General Cleaning		200.00		500.00		790.00		600.00
		TOTAL		$ 132.352.00		$ 135.105.00		$ 135289.50		$ 136.090.00

ITEM	APPROXIMATE QUANTITY	DESCRIPTION	J.H. POMEROY & CO., INC. 333 MONTGOMERY SAN FRANCISCO		McDONALD & KAHN CO., LTD. FINANCIAL CENTER BUILDING SAN FRANCISCO		D.W. NICHOLSON. 357 TWELVE STREET OAKLAND	
		BIDDERS BOND	$ 22.000.00				$ 15.000.00	
		CERTIFIED CHECK			$ 15.000.00			
			UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL
1	10	Cubic Yards of Concrete	129.00	1,290.00	25.00	250.00	72.00	720.00
2	1500	Pounds Reinforcing Steel	.10	150.00	.06	90.00	.06	90.00
3	25	Thousand Feet Board Measure Timber - Untreated	57.00	1,425.00	60.00	1500.00	51.00	1,275.00
4	5	Thousand Feet Board Measure Timber - Creasoted	110.00	550.00	80.00	400.00	100.00	500.00
5	660000	Pounds Structural Steel	.061	40,260.00	.052	34,320.00	.06	39,600.00
6		Corrugated Asbestos Roofing and Siding. Lump Sum		23,120.00		22,500.00		22,000.00
7		Steel Window		7,330.00		8,500.00		7000.00
8		Rough Carpentry		8640.00		12,000.00		9186.00
9		Finish Carpentry		4760.00		5,000.00		6500.00
10		Roofing		3,900.00		3,000.00		3300.00
11		Glass and Glazing		4,860.00		5,000.00		4,800.00
12		Mastipave Flooring		470.00		400.00		400.00
13		Painting		6,760.00		8,500.00		6500.00
14		Finish Hardware		2900.00		3,500.00		3000.00
15		Plumbing		12,310.00		14,000.00		15,000.00
16		Electrical Work		16,328.00		16,000.00		15,600.00
17		Sheet Metal		1,240.00		1,000.00		925.00
18		Metal Partitions		1,670.00		1,500.00		1560.00
19		Lathing and Plastering		650.00		1,000.00		700.00
20		General Cleaning		675.00		1,000.00		1200.00
		TOTAL		$ 139.288.00		$ 139.460.00		$ 139856.00

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE

BIDS OPENED 2:00 P.M. JULY 27, 1938
RM 811-500 SANSOME ST., SAN FRANCISCO

TOLL PLAZAS
YERBA BUENA ISLAND

CONTRACT Nº 19

TABULATION OF BIDS

ITEM	DESCRIPTION		BARRETT & HILP	D. W. NICHOLSON	FRED J. EARLY JR.	BATES & ROGERS CONST. CORP.	CLINTON CONST. Cº OF CALIF	HEAFEY-MOORE CO. FREDRICKSON & WATSON CONST. CO.
			918 HARRISON ST SAN FRANCISCO	357 TWELTH ST. OAKLAND	369 PINE ST SAN FRANCISCO	P.O BOX 1018 OAKLAND	923 FOLSOM ST. SAN FRANCISCO	873 - 81 ST. AVE. OAKLAND
		BIDDERS BOND		$ 1600 00	$ 2500 00	$ 2500 00		
		CERTIFIED CHECK	$ 2000 00				$ 2500 00	$ 2000 00
			AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT
1	PERMANENT TOLL PLAZA	LUMP SUM	5700 00	6750 00	5990 00	7280 00	7100 00	9000 00
2	ELECTRICAL WORK	LUMP SUM	5000 00	5500 00	5369 00	5430 00	4900 00	5000 00
3	PLUMBING	LUMP SUM	1000 00	930 00	1245 00	885 00	1000 00	800 00
4	PERMANENT OFFICE	LUMP SUM	1200 00	1050 00	1466 00	1415 00	2000 00	2900 00
5	TEMPORARY TOLL PLAZA	LUMP SUM	2000 00	1620 00	1908 00	2620 00	2900 00	1790 00
		TOTAL	$ 14.900 00	$ 15.850 00	$ 15,978 00	$ 17,630 00	$ 17,900 00	$ 19,490 00

UNDERGROUND
CONSTR'T'N CO

354 HOBART ST.

OAKLAND

7000.00

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE

BIDS OPENED 2:00 PM · MARCH 15, 1939
RM 811 - 500 SANSOME ST, SAN FRANCISCO

ADMINISTRATION BUILDING ANNEX

CONTRACT Nº 20

TABULATION OF BIDS

				D.W. NICHOLSON-		CHRISTENSEN & LYONS		BARRETT & HILP		C.T. TEIGLAND		E.T. LESURE	
				357 - 12TH ST. OAKLAND		2009 PACIFIC AVE ALAMEDA		918 HARRISON ST SAN FRANCISCO		525 - 49TH ST. OAKLAND		87 ROSS CIRCLE OAKLAND	
		BIDDERS BOND			6000.00		6000.00				6500.00		6500.00
		CERTIFIED CHECK							7000.00				
ITEM	APPROX QUAN	DESCRIPTION		UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL
1	460	Cubic Yards Excavation		2 00	920 00	2 50	1150 00	2 75	1265 00	3 27	1504 20	3 50	1610 00
2		Cutting Pile Heads	Lump Sum		200 00		250 00		200 00		368 00		525 00
3	140	Cubic Yards Foundation Concrete		14 00	1960 00	11 00	1540 00	13 00	1820 00	11 85	1659 00	14 00	1960 00
4	420	Cubic Yards Structural Concrete		29 00	12180 00	27 00	11340 00	27 50	11550 00	25 50	10710 00	23 00	9660 00
5	80000	Pounds Reinforcing Steel		00 05	4000 00	00 04⅓	3466 67	00 0425	3400 00	00 041	3280 00	00 04	3200 00
6		Cutting and Removing Concrete	Lump Sum		250 00		110 00		370 00		162 00		160 00
7		Waterproofing	Lump Sum		100 00		430 00		450 00		420 00		460 00
8		General Construction	Lump Sum		26000 00		28348 19		28800 00		29933 00		30422 00
9		Heating and Plumbing	Lump Sum		6000 00		6000 00		6200 00		6370 00		6354 00
10		Electrical Work	Lump Sum		4800 00		5400 00		5300 00		5640 00		5950 00
11	100	Barrels Extra Cement		1 70	170 00	2 20	220 00	2 20	220 00	2 70	270 00	2 50	250 00
12	1	Incinerator	Lump Sum		900 00		900 00		775 00		950 00		875 00
			TOTAL		57480 00		59154 86		60350 00		61266 20		61426 00

				BATES & ROGERS CONSTR'T'N CORP.		P.J. WALKER CO		FRED J. EARLY JR.		CLINTON CONSTRUCT'N COMPANY		UNDERGROUND CONSTR'T'N CO.	
				P.O. BOX 1018 OAKLAND		607 SHARON BLDG. SAN FRANCISCO		369 PINE ST. SAN FRANCISCO		923 FOLSOM ST. SAN FRANCISCO		354 HOBART ST. OAKLAND	
		BIDDERS BOND			7000.00		10% of bid		8000.00				7000.00
		CERTIFIED CHECK									7000.00		
ITEM	APPROX QUAN	DESCRIPTION		UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL	UNIT PRICE	TOTAL
1	460	Cubic Yards Excavation		2 50	1150 00	4 00	1840 00	3 00	1380 00	4 00	1840 00	1 00	460 00
2		Cutting Pile Heads	Lump Sum		210 00		320 00		800 00		150 00		700 00
3	140	Cubic Yards Foundation Concrete		12 00	1680 00	15 00	2100 00	15 00	2100 00	12 50	1750 00	20 00	2800 00
4	420	Cubic Yards Structural Concrete		30 00	12600 00	30 00	12600 00	30 00	12600 00	26 00	10920 00	30 00	12600 00
5	80000	Pounds Reinforcing Steel		00 04	3200 00	00 042	3360 00	00 05	4000 00	00 045	3600 00	00 055	4400 00
6		Cutting and Removing Concrete	Lump Sum		145 00		125 00		400 00		1000 00		400 00
7		Waterproofing	Lump Sum		390 00		100 00		400 00		760 00		150 00
8		General Construction	Lump Sum		30535 00		31000 00		26850 00		30000 00		30688 00
9		Heating and Plumbing	Lump Sum		5565 00		5500 00		7000 00		6600 00		6000 00
10		Electrical Work	Lump Sum		4850 00		4800 00		6000 00		5000 00		6000 00
11	100	Barrels Extra Cement		2 10	210 00	3 00	300 00	3 00	300 00	3 00	300 00	2 50	250 00
12	1	Incinerator	Lump Sum		900 00		300 00		900		1000 00		1000 00
			TOTAL		61435 00		62345 00		62730 00		62920 00		65448 00

25-A—Inspection Buildings (Contract No. R-8)
Yerba Buena Island Toll Plazas (Contract No. 19)

Administration Building Annex (Contract No. 20)
Maintenance Buildings (Contracts Nos. 21–22)